## FOR FURTHER TRAN TELLIA

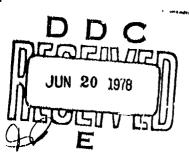
NAMRL -- 1240



James D. Grissett, James L. Kupper Matthew J. Kessier, Richard J. Brown, George D. Prettyman Larry L. Cook, and Toby A. Griner







78 06 15 042

November 1977

IOC FILE COF

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSAGOLA FLORIDA

Approved for public release; distribution unlimited.

Approved for public release, distribution unlimited.

# EXPOSURE OF PRIMATES FOR ONE YEAR TO ELECTRIC AND MAGNET!C FIELDS ASSOCIATED WITH ELF COMMUNICATIONS SYSTEMS

James D. Grissett, James L. Kupper, Matthew J. Kessler, Richard J. Brown, George D. Prettyman, Larry L. Cook, and Toby A. Griner

Naval Medical Research and Development Command XSB09.ED6.6-B1

Approved by
Ashton Graybiel, M.D.
Assistant for Scientific Programs

Released by
Captain R.E. Mitchel, MC USN
Commanding Officer

ACCESSIO	H for	
NT/\$	White Section	1
DOC	Buff Section	
UNANNOUN	(CED	H
JUSTIFICA	TION	د
***		
DISTRIBU Dist.	TION/AVAILABILITY COD	

7 November 1977

NAVAL AEROSPACE MEDICAL RESZARCH LABORATORY PENSACOLA, FLORIDA 32508

78 06 15 042

#### PREFACE

The United States Navy requested the National Acrdemy of Sciences to:
1) assess the adequacy of existing data as a basis for determining biological and ecological effects of an ELF communications system; 2) identify the effects, if any, that may be of major condern; 3) identify critical inadequacies in the available data; and 4) suggest research projects designed to produce needed data. The Committee on Biosphere Effects of Extremely-Low-Frequency Radiation was appointed by the Academy and charged with this task. The research project reported here was being conducted at the same time the Committee was conduring its review. The Committee has published its report; readers of both that Committee report and this research report will need to know what data published in this research report was available to the Committee before completing their report.

In June 1976 the authors presented to the Committee an interim report containing data for 24 weeks of exposure, but did not have separate plots for male and female animals. In January 1977 the Committee met in Pensacola, Florida, and conducted a site investigation of the project. The facilities were examined and interviews were conducted with the professional staff. The authors presented a data supplement to the Committee containing plotted data for 53 weeks of exposure, but again, this data did not have separate plots by sex. The Interim report and data supplement did not include statistical analysis. A two-factor analysis of variance using repeated measurements on one of the factors was adapted to the electronic data handling system and applied to all parameters in the accumulated data bank that were either normally distributed or could be transformed to a normal distribution. Results of this analysis were compiled in the form of a Statistical Supplement and sent to the Committee in April 1977. The Mann-Whitney U-Test was subsequently adapted and applied to the parameters that were not suitable for the analysis of variance. Results of the Mann-Whitney U-Test were not transmitted to the Committee because they revealed no significant effects and the Committee was drafting its final report. The electronic data handling system was then modified to separate male and female data for plotting and statistical analysis. This analysis provided the first indication that a sex-specific effect may have occurred. By this time, the Committee had finished its report; therefore, this preliminary information was not transmitted to the Committee. Analysis by sex was then completed for all parameters and reduced to a format suitable for publication in the present report. Except for a brief summary delivered at Airlee House, Virginia, on 3 November to the 1977 International Symposium on the Biological Effects of Electromagnetic Waves, sponsored by the International Union of Radio Science, this is the first publication of these data.

#### SUMMARY PAGE

#### THE PROBLEM

The U.S. Navy has proposed a submarine communications system that operates at extremely low frequencies. In order to more thoroughly evaluate the biological and ecological effects which could not be adequately predicted on the basis of available data in the literature, the Navy initiated an in-depth laboratory analysis. Experimental animals were exposed for long periods to electric and magnetic fields similar to or greater than those that would appearenced by man living near the antenna. Thirty experimental rhesus mankeys were matched with thirty controls and exposed for one year.

#### FINDINGS

Although not considered abnormal, the most significant finding was the difference in rate of weight gain between exposed and control males. The exposed males gained weight at a slightly faster rate than the control males and at the end of one year were approximately 11% heavier than the controls. The difference in weight was not accompanied by an increase in bone length measurements. The linear body measurement showing the most agreement with the growth rate difference was chest circumference. In the exposed females serum triglycerides and respiratory quotient were slightly lower than in the female controls. There is no indication that these findings have, any adverse clinical significance and both greups of animals appear quite healthy.

## **RECOMMENDATIONS**

These animals should continue to be exposed and the data collection protocol should concentrate on identifying the mechanisms for these effects so that the long term effects can be predicted on the basis of physiological theory. The sexual specificity of these results suggests that endocrine involvement should be studied extensively.

#### **ACKNOWLEDGMENTS**

The authors gratefully acknowledge members of the Biomedical Division, the Veterinary Sciences Division, the Electronic Services Division, the Shop Services Branch, and the Visual Aids Branch, who supported this project with many months of dedicated service.

The animals used in this study were handled in accordance with the Principles of Laboratory Animal Care established by the Committee on the Guide for Laboratory Animal Resources, National Academy of Science-National Research Council.

## TABLE OF CONTENTS

		Pag	је
1.	INTE	RODUCTION	1
11.	PROC	EDURE	
	Α.	SUMMARY OF RESEARCH DESIGN AND METHODS	2
	В,	ANIMAL SELECTION, PAIRING, AND RANDOMIZATION	3
	С.	ELECTRIC FIELD GENERATING SYSTEM	4
	D.	MAGNETIC FIELD GENERATING SYSTEM	8
	Ε.	RESPIRATORY GAS ANALYSIS	0
	F.	CLINICAL EXAMINATIONS AND ROUTINE MONITORING 1	5
	G.	BLOOD CHEMISTRY PARAMETERS AND METHODS	5
	н.	STATISTICAL ANALYSIS METHODS	9
	١.	START-UP PROCEDURE AND SCHEDULE	4
ш.	RESU	ULTS	
	Α.	VETERINARY CLINICAL EVALUATIONS	7
	В.	BLOOD CHEMISTRY PLOTS	0
		1. Proteins	
		a. Total Protein	1 7 3 9 5
		a. Cholesterol	Ç,

																					Page
			Pre-be Beta l																•	•	101 107
	3.	Hema t	ology																		
			Hema to										-								113
			Hemog														•	•	•	•	119
			Mean (																•	•	125
			Mean (																•	•	131
			Mean ( Red Bi															•	•	•	137
			White													٠		•	•	•	143
			Lympho																•	٠	149
			Monocy													•		-	•	•	155
			Polyne									:					-	•	•	•	161
		_	Eosino													-	-	•	•	•	167
			Basopl																•	•	173
			Bands.																	•	179
					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	185
	4.	Elect	rolyte	35																	
		a.	Sod I ur	n.																	191
		b.	Potas	s i um.										J							197
		c.	Chlor	ide .																	203
		d.	Calci	ım.	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	209
	5.	Enzym	es																		
			Serum																		
			(SGOT)		•																215
			Serum																		221
			Lacta																		227
			Creat																		233
		e.	Gamma	GIU	camy	Ή,	ır	an	sp	ep	ti	ua ''B''	se	(	G	ilP	)	•	•		239
		f.	Phospl	none	KOSE	: 1	SO	me	ra	se	(	,PH	1)	•	•	•	•	•	•	•	245
	6.	Gluco	se .	• •		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	251
	7.	Blcod	Urea	Niti	roge	n	(B	UN	)					.`		•					257
	8.	Thyro	id Par	rame	ters																263
С.	HUDA	WEIGH	т																		_
	0001	WETGII		•	• •	•	•	•	•	•	•	•	•	•	•	•	•	•	٠	•	273
D.	RESPI	RATOR	Y GAS	ANA	_YS!	S	•	•	•	•	•	•	•	•	•	•	•	•	•	•	283
	1.		n Cons				•								•						284
	2.	Carbo	n Dio	kide	Pro	du	ct	lo	n	•						•	•				290
	3.	Respi	ratory	y Que	otle	n t				•		•		•		•					296
	4																				-

		Page
	E. STATISTICAL SUMMARY	299
IV.	DISCUSSION	310
٧.	REFERENCES	314

٧

.

#### INTRODUCTION

Considerable research has been done at this and other laboratories to determine the physiological and psychophysiological effects of electric and magnetic fields similar to those that would be present near the antenna of the U.S. Navy's proposed ELF communications system. Exposure times have ranged from a few hours to seven weeks. Most parameters measured did not appear to be affected by the ELF fields; however, some parameters did show a statistical correlation with exposure, but for various reasons a firm cause and effect relationship could not be established. In many cases, the number of exposed subjects was small and/or the exposure times were short. Although not conclusive, these findings identified areas for further, more intensive investigation.

One series of experiments at this laboratory suggested that lipid metabolism might be affected by ELF magnetic fields. Ten human volunteer male subjects were exposed for periods of one day to a magnetic field of 0.1 mT (one gauss) at 45 Hz (1). Test results were compared for periods before, during and after exposure. At different times, five control subjects participated in the same experimental protocol except that the field generating coils were not energized. No effects of the field were observed on ECG, vital signs, respiratory gas analysis, reaction time, pupillography, scotopic critical flicker frequency, short-term memory, and hand-eye coordination. Blood chemistry values were not changed with the exception of serum triglycerides, which in nine experimental subjects reached a maximum 24 to 43 hours after exposure. A similar trend was not seen in the control subjects.

Another experimental series conducted at our laboratory was designed to detect changes in operant behavior of rhesus monkeys and squirrel monkeys exposed to ELF fields (3-8). These experiments covered a variety of behavioral tasks and exposure conditions but showed no behavioral effects that could be correlated with the fields.

In December 1973, the Bureau of Medicine and Surgery, Department of the Navy, convened an "Ad Hoc Committee For the Review of Blomedical and Ecological Effects of ELF Radiation." Subsequently, the Blomedical Division, NAMRL, developed a proposal which complied with and greatly exceeded the intent of the priority 1a and 1b recommendations of this committee. The proposal for chronic emposure of primates to ELF fields was submitted to the Bureau of Medicine and Surgery on 2 April 1974. The project was approved and work began 22 July 1974.

It was anticipated that approximately 2.5 years would be required to complete the project. Approximately one year would be required to construct and/or modify a building, design and fabricate apparatus, select experimental animals, assemble appropriate staff, and procure supplies and equipment. Exposure and data collection would occur during the second year. In the first half of the third year histopathological and histochemical examinations would follow and a project report prepared. This original estimate has been reasonably accurate. The building was completed 29 September 1975. During the month of October the fabricated apparatus, equipment, and supplies were moved into the building and assembled. The field was activated and exposure began on 27 October 1975.

#### **PROCEDURE**

#### SUMMARY OF RESEARCH DESIGN AND METHODS

Essential design considerations for this chronic exposure were selection of animal species, number of animals, length of exposure, exposure parameters, and type of data collected.

The rhesus monkey (Macaca mulatta) was selected as the experimental animal because it is a highly developed species that has been used in medical research for many years; therefore, a large amount of physiological data has been accumulated on this species by the research community. Adult rhesus were not included because of limited availability and logistical difficulties associated with care and handling of larger and stronger animals. Using young animals of different sex presented some statistical difficulties, but these problems were counterbalanced by gaining important data on growth and development.

In experiments of this type, in which subtle effects and trends within the normal range are vitally important, it is not sufficient for subjects to serve as their own controls by comparing pre-, per-, and post-exposure data. In this project each experimental animal was pair-matched to a control by age, sex, weight, and medical history. All data were taken from both members of the pair at the same time and under the same conditions.

The number of animals in each group was set at 30 because a sample of this size usually provides an adequate basis for statistical analysis. Since each of the 30 experimental animals had a matched control, the groups were also matched. This arrangement allowed both group-to-group and animal-to-animal comparison. An exposure time of one year was selected to allow time for subtle physiological effects to be detected and to provide a detailed time course for each animal.

The animals in this experiment were individually housed in a sealed chamber to allow for measurements of oxygen consumption and carbon dioxide production and to reduce the possibility of spreading a communicable disease among the entire group. Blood samples were drawn at intervals of seven days for biochemical analysis. Every sixth week the animals were placed in restraint chairs for seven days. Blood samples taken during restraint were analyzed for those constituents that were particularly labile and subject to the psychophysiological stress normally associated with capture and manual restraint prior to venipuncture. At the end of each restraint period, the animals were given a comprehensive physical examination by a veterinarian experienced in the clinical physiology of rhesus monkeys.

The experimental animals were exposed to fields equivalent in waveform to those experienced by living organisms, including man, in contact with the soil surface directly above the buried ELF antenna. The magnitude of the magnetic field, 0.2 mT (2 gauss), was ten times greater than the average field along the ELF antenna. The electric field, 20 V/m, was over 300 times greater than at the soil surface above and along the antenna; it was two times greater than at the soil surface near the ground terminal. The electric field was applied to the animal via stainless steel bars which formed the walking surface on the floor of the environmental chamber.

The facility was designed so that either the north or south wing could be used to expose experimental animals. Both wings had identical field generating equipment. When the experimental animals were in position in the north wing, the control animals were in corresponding positions in the south wing but only the north wing field generating system was energized. These identical systems allowed the two animal groups to be transposed each week, thus balancing subtle differences in environmental control equipment, data transducers, recorders, noise level, vibrations, etc.

The ELF fields were on for 22 hours daily. The other two hours were used for feeding, drawing blood, physical examinations, changing cages, and general maintenance activity. The lights in the animal wings were turned on at the beginning of this two-hour period and remained on for twelve hours. The animals usually consumed their food within six hours after feeding. This factor in animal behavior and the twelve-hour dark period immediately before drawing blood insured a reasonably good fasting blood sample. At the end of the two-hour maintenance period the animal doors were locked and the field restored.

When the project was originally proposed, it was intended that half of the experimental and half of the control animals would be sacrificed at the end of the exposure period and given an intensive pathological and histochemical examination. The remaining animals would be kept for at least two years and given a complete physical examination quarterly. This part of the protocol was postponed. At the end of one year the clinical data suggested that an immediate pathological examination would reveal very little new information. As an alternative it was proposed that all the animals remain in position with the same exposure parameters applied to the experimentals. As proposed, the project has been continued; this report is for the first year only.

## ANIMAL SELECTION, PAIRING, AND RANDOMIZATION

One-hundred and twenty rhesus monkeys were initially purchased in September 1974 and placed in quarantine for six weeks. During quarantine each animal was physically examined for evidence of infectious diseases and tested for tuberculcsis. The entire group was released from quarantine after three consecutive negative intrapalpebral tuberculin tests. Blood samples were then obtained from each animal and a battery of biochemical and hematological tests performed. Means and standard deviations for each parameter were calculated for the entire group. Animals were excluded from further consideration if any of their lipid values or many of the other

parameters were not within two standard deviations of the mean of the group. Complete physical examinations, as described under Clinical Examination, were then accomplished on the remaining monkeys. A total of 47 animals were deleted for various defects or abnormalities within the following categ hematology, 19; radiography, 8; electrocardiography, 9; dental, 3; death or chronic illness, 5; and miscellaneous, 3. From the remaining 73 monkeys, 32 pairs were selected for the project on the basis of sex, age (dentition), weight, and size. Sixteen pairs of females and fourteen pairs of males were identified for the project; the other pairs were designated as alternates. Population data at the time of selection has been developed as follows: mean age of females, 50.7 months; mean age of males, 43.4 months; mean weight of females, 4.74 kg; and mean weight of males, 6.25 kg. These data indicate that the animals were in puberty with the females closer than the males to maturity. The animals were identified by tattoo numbers on the chest. The chest numbers for each pair were written on a small piece of paper and placed in a container. The 30 pieces were then mixed and withdrawn by 30 consecutive draws. The first draw was labeled pair number one, the second draw labeled pair number two, and so on with the last draw labeled pair number thirty. One monkey of each pair was assigned to the red group or blue group by the flip of a coin and the remaining member of the pair was assigned to the opposite group. Red and blue groups were designated experimental and control by the principal investigator without the knowledge of the other investigators. Each animal's position and group were thus randomly selected.

#### ELECTRIC FIELD GENERATING SYSTEM

Experimental and control animals were housed in sealed plexiglass chambers that used liquid rather than gasket seals. The bottom section of the chamber shown in Figure 1 consisted of the feces tray with bars that formed the walking surface for the animal. The bars were constructed of 1.27 cm square stainless steel bar-stock and they lay in slots spaced 3.81 cm between centerlines. The bars rested on thin stainless stee! strips 3.5 cm long which bridged the floor of the slots. These strips were then connected by 3900 ohm resistors as shown in Figure 2. The end resistors were connected to a stainless steel strip which passed down into the trough and terminated on the outer edge of the feces tray. A current source was connected via these terminations to the network of resistors and an electric field gradient of 0.76 volts was generated between adjacent bars. An animal simultaneously contacting two or more bars had a body current similar in waveform and about six times greater than that which he would experience if he were in contact with the soil surface near the ground terminals of the ELF antenna. This body current was 300 times greater than would be experienced along the antenna at points away from the ground terminal. The current source for this electric field simulator was driven by an amplifier with an input from the same modulator used for the magnetic field generator. Wire screens as shown in Figure 3 were placed on each side of the animal and connected to the same voltage source that energized the resistor network. These screens created a uniform horizontal electric field similar to that near the ELF antenna. The electrical schematic for this arrangement is shown in Figure 4.

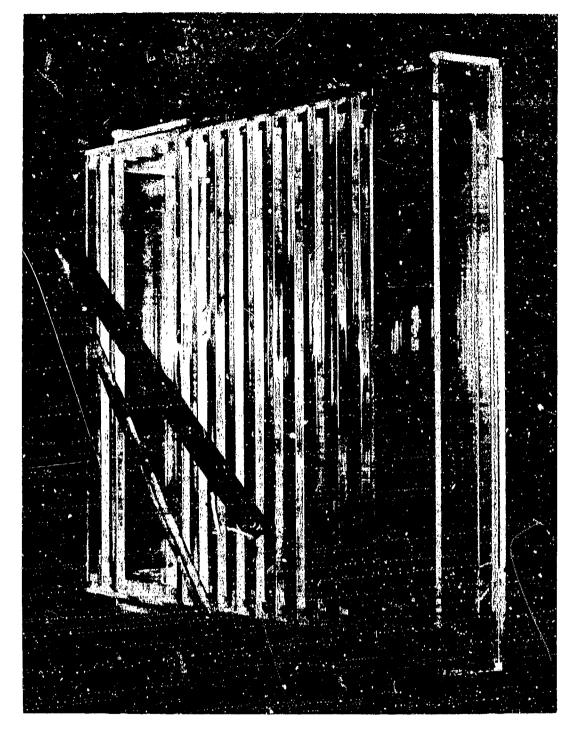


FIGURE 1. The bottom section of the plexiglass animal holding chambers were constructed so that the bars could be removed for cleaning. The middle section fits into a trough on the outer edge.

**的时间,我们是一个时间,我们是不是一个时间,我们是一个时间,我们是一个时间,我们们是一个时间,我们们是一个时间,我们们是一个时间,我们们是一个时间,我们是一个时间,** 



FIGURE 2. Resistors in the bottom section of the plexiglass animal holding chamber were used to simulate soil conductivity and produce a voltage gradient along the animal's walking surface. The resistors (3900 ohms) were embedded in clear water proof insulation and the leads were soldered to conducting strips which contacted the bars that were placed in slots between the resistors. The bars were in contact with an identical system at both ends so that the net resistance between bars was 1950 ohms. FIGURE 2.



FIGURE 3. Vertical wire screens were on two sides of the animal chambers and were connected to the electric field voltage source. The screens created a uniform horizontal electric field.

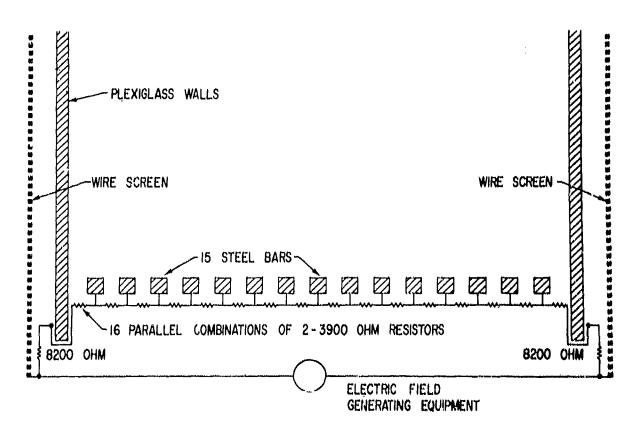


Figure 4. Schematic of the electric field generating system. An identical network of resistors were at both ends of the bars so that the net resistance between bars was actually formed by two 3900 ohm resistors in parallel.

The electric field distribution in the animal chambers was measured with the ITT Research institute high impedance electric field probe in conjunction with an HP 3581 Wave Analyzer. At four elevations in the chambers measurements were taken near the corners and in the center as shown in Table 1. The electric field screens would be on the right and left. These particular values were recorded at position 30 in the south wing; however, they are typical of values recorded at other positions.

## MAGNETIC FIELD GENERATING SYSTEM

The magnetic field generating system was designed to simulate the magnetic field associated with an ELF communication system. The current carrying conductors were beneath the animal chamber at approximately the same distance that the buried cable of the communications system would be from the soil surface. The field direction was horizontal in the north-south direction and approximately one order of magnitude higher than in the ELF communications system.

TABLE I

FIELD DISTRIBUTION

	HEIGHT ABOVE WALKING SURFACE		P (	POSITION	0 K	
		Left Front Corner	Right Front Corner	Center	Left Rear Corner	Right Rear Corner
Electric Field Distribution (V/m)	69 cm	6.350	12.220	14.080	8.410	9.010
	52 an	22.110	28.350	17.000	24.530	26.830
	42 cm	24.290	25.620	19.650	27.990	23.460
	10 cm	27.930	22.440	19.110	28.450.	20.540
Magnetic Field Distribution (mT)						
	69 cm	0.118	0.117	0.109	0.110	(113
	₽2 cm	0.147	0.144	0.146	0.144	0.141
	וס כימ	0.203	0.189	0.194	0.197	0.197

The coil system consisted of three parallel wire bundles 26 m long. These bundles were laid in concrete trenches 1.1 m deep and 1.1 m wide as shown in Figure 5. Eighty-six turns were in the center trench. 48 turns in the outer trench (right side of Figure 5) and 38 turns in the inner trench (left side of Figure 5). The bundles were spaced at 3 m and connected at each end such that the entire system consisted of a single continuous copper wire cable wound in the form of two adjacent rectangles with a long common side. The reinforcing steel bars in the concrete were broken at intervals to prevent inductive generation of a secondary current loop In the steel bars. The trenches were covered with plywood, and a row of 30 animal chambers was placed approximately 1.1 m directly above the center coil as shown in Figure 6. The system generated a field of 0.2 mT (2 gauss) in the chambers and simultaneously generated a null field in the control chambers placed along a parrile; line 25.8 m from the experimental chambers. The control chambers were placed above a coll system identical to that which exposed the experimen 'animals. These identical coll systems could not be energized at the same time; the modulator and amplifier were switched to the other coil when one animals were transposed. The group first designated as experimentals retained that status; they were merely being exposed by a different coll system on the opposite side of the building.

At pseudorandom intervals the oscillator shifted between 72 Hz and 80 Hz. At the time of the shift the coll system was instantaneously tuned to the correct frequency. This automatic tuning was accomplished by solid state switching which changed the value of total capacitance in resonance with the coll system.

The magnetic field distribution in the animal chambers was measured with the IIT Research Institute magnetic field probe in conjunction with a Hewlett Packard 3581 Wave Analyzer. At three elevations, measurements were taken near the corners and in the center as shown in Table 1. Adjacent chambers would be on the right and left and the magnetic field vector would be in the horizontal plane and perpendicular to the row of animals. These particular values in Table I were recorded at position 30 in the south wing; however, they are typical of values recorded at other positions and for the other field generating system. These values are approximately ten times greater than fields at comparable positions near the ELF antenna.

#### RESPIRATORY GAS ANALYSIS

The middle section of the environmental chamber was open at the top and bottom and fits into the external trough of the feces tray. The animal entered the chamber from the top and was secured by a sheet of plexiglass in grooves at the top of the middle section. The animal's food and water supply was placed on this sheet and dispensed to the animal through approriate channels. A final section similar to an inverted open box fitted



FIGURE 5. Coils that generated the magnetic field were laid in concrete trenches at the time of building construction. Three expansion joints were placed in the concrete walls and floor to prevent secondary current loops in the steel reinforcing bars.

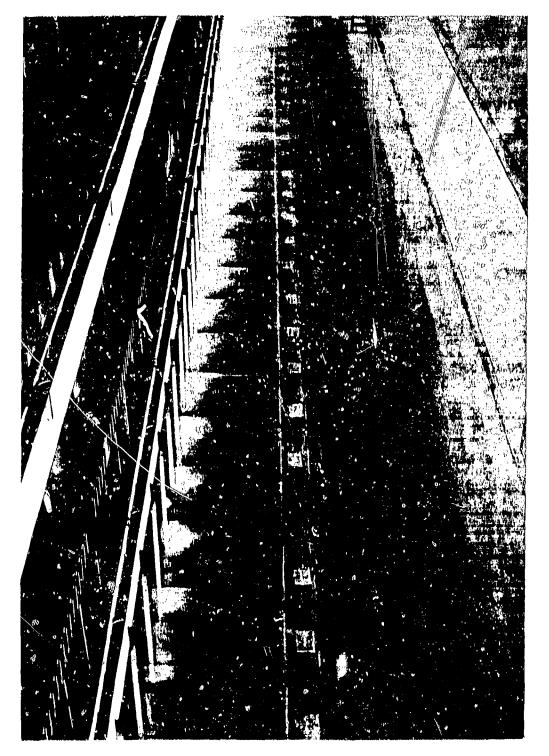


FIGURE 6. Thirty animal chambers were placed in a line directly above the center trench. The magnetic field was horizontal and perpendicular to this line and the electric field was horizontal and parallel to this line.

into a trough surrounding the top part of the middle section. Internal dimensions of the volume to which the animal was confined were 0.6 m  $\times$  0.6  $\times$  0.76 m high. A row of full spectrum lights was directly over the row of cages. Direct light reached the animal after passing through two layers of plexiglass that were designed to pass the full spectrum.

The chamber was made airtight by filling the troughs with a suitable liquid. Water was in the upper trough and mineral oil was in the lower trough. A nonconducting fluid was required in the lower trough because of the stainless steel strips that passed through this liquid to provide an electrical connection between an outside current source and the inside bars.

The external environmental control equipment as shown in Figure 7 was connected to openings in the top and middle sections of the animal chamber such that the flow of air was down through the center section, past the bars, into the feces tray, and out. The ventilation system operated either as an open system or as a closed recirculating system. In the open system mode, room air entered the chamber through a filter and air leaving the chamber was exhausted to the atmosphere. The closed system mode was used to measure oxygen consumption and carbon dioxide production. In this arrangement air leaving the feces tray passed through 2 meters of plastic pipe to another, but much smaller, sealed chamber. The air was driven by a fan in this chamber which forced the air through carbon dioxide absorbent, a heat exchanger, and back to the top of the animal chamber. The heat exchanger had a constant flow of 25°C water and removed body heat and heat generated by the reactions associated with carbon dioxide absorption. Pressure was maintained in the system by allowing pure oxygen to enter at the same rate that oxygen was removed from the chamber by the animal's metabolic processes.

Oxygen entering the system passed first through four stages of regulation and a wet test gas meter. The combined function of the regulators was to keep the static pressure on the chamber between 2 cm and 4 cm of water which would not break the liquid seals on the chamber. The wet test meter measured oxygen consumption rate by triggering an event recorder at 500 ml intervals. The total oxygen consumed was also indicated by the totalizing dials on the gas meter. The carbon dioxide expiration rate was measured for a 22-hour period by chemical analysis of the absorber to determine the total amount of carbon dioxide absorbed.

The system was operated in the closed circuit mode for a 22-hour period at seven-day intervals. It was always the first 22 hours after the animal had been placed in a clean chamber, thus preventing the animal from rebreathing gases evolved from accumulated feces and urine. The remaining six days were in the open circuit mode with ventilation to the atmosphere.

Approximately 1200 g of carbon dioxide absorber (Sodasorb, W.R. Grace & Co., Lexington, MA 02173), was weighed, transferred to a permeable bag,



FIGURE 7. External environmental control systems. Room air entering the top of the chamber flowed down into the feces tray and out of the building via a corrugated exhaust hose. To measure oxygen consumption the chambers were connected to an external chamber where carbon dioxide was semoved and oxygen replenished.

and positioned in the closed system. After approximately 22 hours, the bag of absorber was removed and reweighed to obtain a total weight of the absorber after exposure to the respiratory gases. A uniform sample was immediately removed and stored in an air-tight bottle.

Approximately 15 g of the exposed absorber was weighed and transferred to a 500-ml flask. Fifty milliliters of 50% reagent grade HCI were added to the flask which was immediately connected to a one liter spirometer (Warren E. Collins, Inc., Braintree, MA). The spirometer was calibrated to measure the carbon dioxide expelled from the absorber. The flask was maintained at 25°C in a constant temperature water bath until all of the carbon dioxide had been expelled from the sample. An unexposed sample of absorber taken before filling the porous bag was also measured for a blank value.

#### CLINICAL EXAMINATION AND ROUTINE MONITORING

Members of a matched pair were given physical examinations at the same time. The examining veterinarian and his staff did not know which animal was experimental or control. Electrocardiograms, electroencephalograms, and systolic blood pressure (Doppler method) were completed one week before the veterinarian's examination. The vaterinarian's examination included the following: observation of- ocular motility, direct and indirect pupillary reflexes, facial muscle tone, locomotor and proprioceptor activity, disposition and demeanor; visual and manual examination of- head, face, scalp, neck, mouth, teeth, throat, extremities, skin, haircoat, superficial spine, and perineal region; direct ophthalmoscopy; otoscopic visualization of external auditory canal and nares; palpation of- abdomen, superficial lymph nodes, femoral pulse, and insulnal canals; auscultation of heart and lungs; elicitation and evaluation of- the palmer, plantar, patellar tendon, superficial abdominal, and auditory-palpebral reflexes. Rectal swabs were taken for bacteriologic examination. These comprehensive examinations were given at six-week intervals.

In addition to the physical examinations, the veterinarian and his professional staff performed the following tasks daily: observed blood collection procedures; visually examined every monkey and chamber; made notations on estrous cycle phases; reviewed food and water consumption records; checked weight charts of animals weighed on that day; inspected sanitary conditions of the animal areas, the examination room, and the chamber washing areas; and collected bacteriological samples on a regular schedule from all animal associated areas.

#### BLOOD CHEMISTRY PARAMETERS AND METHODS

Blood samples were drawn early in the morning with the animals in a fasting condition. Five milliliters were drawn from the femoral vein using 10-ml disposable syringes with 20 gauge/38-millimeter disposable needles. One milliliter to be used for hematology parameters was injected into 5-ml tubes (Venoject, Kimble-Teruno, Inc.) containing 7.5 mg of an anti-coagulant (EDTA). The remaining blood was transferred to disposable glass test tubes for coagulation. These tubes were then centrifuged and the serum transferred to plastic test tubes which were capped and refrigerated until analysis.

Excess serum not required for analysis was preserved at  $-85^{\circ}$ C to be used for other tests that may be desired at a later time.

Before the samples were delivered to the laboratory, the animal's identification number was removed from the container and replaced by a control number. A permanent bound record which matched the animal numbers to the control numbers was kept in a secure safe and was not available to the medical technologists who were analyzing blood samples. This procedure prevented the medical technologists from knowing which data belonged to an experimental or a control. The contents of this permanent record were entered into an electronic file system. In the analytical laboratory, the results of all tests were recorded in permanent bound logs which were retained in the analytical laboratory. These logs were copied and entered into the electronic file system where the results of each test were matched to the animal identification numbers and electronically filed according to animal position, group designation, and date. These data were then available for plotting and statistical analysis.

Unless otherwise indicated, the serum parameters were analyzed using the Gilford Model 3500 automated chemistry analyzer (Gilford Instrument Laboratories, Inc., Oberlin, Ohio). Prepared reagents for all but two of these were obtained from Worthington Diagnostics, Freehold, New Jersey; blood urea nitrogen and cholesterol reagents were purchased from Abbott Laboratories, Pasadena, California. Two commercially prepared sera were measured along with the serum samples.

#### Total Serum Protein

The bluret reaction was employed in which cupric ions react with proteins in alkaline solution to form a blue-violet colored complex. A total protein standard of known protein concentration was used as a standard in the Gilford 3500.

## Serum Albumin

Albumin was reacted with anionic bromcresol green dye which caused an increase in the green color. This color was measured at 628 nm and was directly proportional to the albumin concentration as compared to a serum albumin standard.

### Serum Glutamic Pyruvic Transaminase (SGPT)

The activity of SGPT is proportional to the rate of a secondary reaction in which NADH is exidized to NAD. The concentration of SGPT was determined by measuring this rate spectrophotometrically at 340 nm.

## Serum Glutamic Oxaloacetic Transaminaso (SGOT)

The activity of SGOT was determined by coupling the reaction it catalyzes to a secondary reaction. In this secondary reaction NADH was oxidized to NAD, permitting the transaminase activity to be determined by the rate of decrease in absorbance at 340 nm.

## Lactate Dehydrogenase (LDH)

Lactate dehydrogenase catalyzed the conversion of lactate to pyruvate and NAD to NADH. LDH activity was determined by measuring the increase in absorbance of NADH measured at 340 nm.

## Creatine Phosphokinase (CPK)

CPK catalyzed the conversion of creatine phosphate and ADP to creatine and ATP. The ATP thus produced and glucose were converted to ADP and glucose-6-phosphate by hexokinase in a secondary reaction. In a tertiary reaction catalyzed by glucose-6-phosphate dehydrogenase, NAD was reduced to NADH. The rate of NADH production measured at 340 nm was proportional to the CPK activity.

## Gamma-Glutamyl Transpeptidase (Y-GTP)

Y-GTP transferred the gamma-glutamyl group from the substrate gamma-glutamyl-p-nitroanilide to glycylglycine producing free p-nitroaniline which absorbed at 405 nm. Enzymatic activity was proportional to the increase in absorbance at this wavelength.

## Phosphohexose Isomerase (PHI)

PHI (glucose phosphate isomerase) catalyzed the isomerization of fructose-6-phosphate to glucose-6-phosphate. The activity of serum PHI was proportional to the rate of a secondary reaction in which glucose-6-phosphate dehydrogenase oxidized the glucose-6-phosphate produced in the first reaction and reduced NAD. The rate of increase in NADH in the second reaction was a measure of the serum PHI activity.

## Blood Urea Nitrogen (BUN)

Urease converted urea into ammonia and carbon dioxide. Glutamic dehydrogenase catalyzed the combination of the ammonia with alpha-keto-glutarate along with the oxidation of NADH to NAD. The resultant decrease in absorbance at 340 nm was directly proportional to the concentration of ammonia which, in turn, was quantitatively related to the concentration of urea initially present. This procedure was based on the comparison of the unknown samples to BUN standards.

## Serum Glucose

In the primary reaction hexokinase catalyzed the phosphorylation of glucose to glucose-6-phosphate. Glucose-6-phosphate was oxidized and NAD reduced in the secondary reaction by glucose-6-phosphate dehydrogenase. Since both reactions were essentially irreversible, the concentration of NADH produced in the secondary reaction, measured at 340 nm, was a direct measurement of the total glucose present in the serum sample when compared to a glucose standard.

## "Cholesterol

Cholesterol esters in serum were hydrolyzed to free cholesterol by cholesterol ester hydrolase. The free cholesterol produced was oxidized by cholesterol oxidase to cholest-4-en-3-one and hydrogen peroxide. The hydrogen peroxide was coupled with 4-aminoantipyrine and phenol in the presence of peroxidase to yield a quinoneimine dye with an absorption maximum at 500 nm. The amount of color produced was directly proportional to the total cholesterol concentration of the sample as compared to cholesterol standards.

## Triglycerides

Serum triglycerides were first saponified with ethanolic potassium hydroxide to produce glycerol and free fatty acids. The free fatty acids were precipitated with magnesium sulfate. The glycerol was then measured by three coupled enzymatic reactions catalyzed by glycerol kinase, phosphokinase, and lactate dehydrogenase. In the third reaction NADH was oxidized to NAD. The total NADH decrease, measured at 340 nm, was directly proportional to the concentration of glycerol present after the saponification process and, therefore, to the concentration of triglycerides present in the sample.

## Calcium

A Corning Calcium Analyzer Model 940 (Scientific Instruments, Corning Glass Works, Medfield, Massachusetts) was used to measure serum calcium concentration. The dye calcein fluoresced in the presence of calcium in an added serum sample. The analyzer automatically titrated this fluorescent complex with EGTA (ethylene glycol bis (B-aminoethylether) N, N'-tetra-acetic acid).

## Chloride

A Corning Chloride Meter Model 920M (Scientific Instruments, Corning Glass Works, Medfield, Massachusetts) was used to measure serum chloride concentration. The operation was based on the titration of chloride with silver ions generated by electrolysis.

## Sodium and Potassium

Sodium and potassium were measured by the G.K. Turner Model 510 flame photometer (G.K. Turner Associates, Palo Alto, California).

### Proteins

Serum proteins were measured by electrophoresis using Gelman Sephaphore III cellulose acetate membranes (Gelman Instrument Co., Ann Arbor, Michigan) and a Beckman Microzone Cell (Beckman Instruments, Inc., Atlanta, Georgia) at 250 volts for 20 minutes. The membranes were stained with Ponceau S stain and measured with a Beckman Model CDS-100 computing densitometer.

## Lipoproteins

Serum lipoproteins were determined by electrophoresis using the Corning-ACI Agarose Film/Cassette System (Scientific Instruments, Corning Glass Works, Medfield, Massachusetts) for 35 minutes at a non-adjustable voltage. The agarose gel films were stained with Fat Red 7B and measured with the densitometer mentioned above.

## Hematology

Total erythrocyte count, total white blood cell count, and hematocrit were determined by using the Model ZBI Coulter counter. The counter was equipped with a channelyzer which displayed the cell-size distributions for accurate setting of the upper and lower window of the counter. Hemoglobin concentration was determined using a Coulter Electronics, Inc. (Hialeah, Florida) hemoglobinometer. The procedure involved was the cyanomethemoglobin-colorimetric method. Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were calculated from data obtained from the Coulter counter and Coulter hemoglobinometer. Differential white blood cell counts were performed by counting 100 white blood cells.

STATISTICAL ANALYSIS METHODS

## Analysis of Variance

The statistical analysis of the data was accomplished with a two-factor analysis of variance (ANOVA) using repeated measurements on one of the factors (12). An unweighted means analysis was employed to compensate for unequal cell frequencies encountered because of missing data. Table II shows the factor scheme and notation.

The exposure level factor contains two levels, an exposure level and a control (no exposure). Within each exposure level, there are repeated measurements on 30 animals. Note that each group has 30 animals for a total of 60. The exposure duration factor consists of 6 levels for the first week analysis and 53 levels for the year analysis. Each animal was sampled once within an exposure duration level.

In an unweighted means analysis, unequal cell frequencies can be used. The computations involve the means of cells and the time-series means of the repeated measurements. The effective number of samples,  $\widetilde{N}$ , is computed as the harmonic mean of the number of samples found within each cell. In a similar manner, the effective number of weeks,  $\widetilde{Q}$ , within the time-series means (required in the effects between subjects) is the harmonic mean of the number of samples found within each time-series record. The computational formulas used are:

$$\widetilde{N} = \begin{array}{c|c} pq \\ \overline{p} & \overline{q} \\ \Sigma & \Sigma \\ j=1 & k=1 \end{array} \begin{array}{c} np \\ \overline{n} & p \\ \Sigma \\ j=1 & j=1 \end{array} \begin{array}{c} np \\ \overline{q}_{ij} \end{array}$$

TABLE II

ANOVA FACTOR SCHEME AND NOTATION

## **EXPOSURE DURATION**

		ANIMAL	W <sub>1</sub>	W <sub>2</sub>			•		Wk			•			<u>.</u> .			Wq	TIME - SERIES MEANS
			Yill	Y <sub>112</sub>					Y <sub>11</sub>	ķ '		•		•	٠.	•		Yilq	A <sup>ii</sup>
		2.	A <sup>511</sup>																
	L <sub>i</sub>		Yiji																Yii.
EVEL	•	n	Ynll																₹ <sub>n1.</sub>
ZE F	: Lj		₹ <sub>.11</sub>	Ÿ <sub>.12</sub>			٠		Ÿ.[]	k <sup>*</sup>		•		•	•	•		Ÿ.I. q.	ΣΥ <sub>.lk</sub>
EXPOSURE LEVEL	•	i	Y <sub>121</sub>	Y <sub>122</sub>			•		۰۲	2k	•		• •				•	· Y <sub>I2q</sub>	Ÿ <sub>12.</sub>
	Ĺp	2	Y2,21																
		;	Yiżı																Yi2.
		n ———	Yn2I		_														Y <sub>n2</sub> .
		<u> </u>	Ÿ <sub>.21</sub>	Ÿ.22		• •	<u>.</u>	• •	• Ÿ.;	2 k .	<u>.</u>	· ·		· ·	•	_	• •	Y <sub>.2q</sub>	Σ 7 <sub>.2 k</sub>
	WEEK	MEANS	$\frac{\sum\limits_{j}^{p}\overline{Y}_{,jl}}{p}$			•				₹ <sub>.j&amp;</sub> •	•		•	• •	•	•	• •	$\frac{\cdot \sum\limits_{j}^{p} Y_{jq}}{\rho}$	1

The computation of the variation, or sum of squares, is designated by the symbol SS. In general, the variation of a data set is the sum of the variations of the measurement points in that set from the mean of that data set.

 $SS = \Sigma (Y - \overline{Y})^2$ 

However, for computational purposes this equation can result in round-off errors. An equivalent expression that reduces round-off error is:

$$SS = \sum Y^2 - (\frac{\sum Y}{n})^2$$

The second part of this expression is called the correction factor. The correction factor term for the ANOVA is:

$$C = \frac{\begin{bmatrix} q & p & \overline{Y}, jk \end{bmatrix}^2}{pq}$$

The sum of squares between subjects (SSBS) consists of the variation of the animal time-series means about the grand time-series mean multiplied by the effective number of weeks.

SSBS = 
$$\begin{bmatrix} p & n \\ \sum_{j=1}^{p} \sum_{i=1}^{n} (\overline{Y}_{ij})^{2} - (\frac{\sum_{j=1}^{n} \sum_{j=1}^{p} \overline{Y}_{ij}}{n \cdot p})^{2} \end{bmatrix} \begin{bmatrix} \widetilde{Q} \end{bmatrix}$$

The sum of squares for the exposure level (SSL) is the variation of the sum of cells means within each exposure level about the grand mean multiplied by the harmonic means.

$$SSL = \begin{bmatrix} p & \left( \frac{q}{\sum_{k=1}^{p} \overline{Y}_{,jk}} \right)^{2} \\ \sum_{j=1}^{p} \left( \frac{q}{k=1} \overline{Y}_{,jk} \right)^{2} - C \end{bmatrix} \begin{bmatrix} \widetilde{N} \end{bmatrix}$$

The error between subjects is the variation of subjects within groups (ERRB) and is the difference between the variation between subjects and the variation of the exposure level.

The sum of squares of the exposure duration factor (SSD) consists of the variation of the exposure duration means about the grand mean.

$$SSD = \left[ \frac{Q}{\sum_{k=1}^{\infty} \left( \sum_{j=1}^{p} \overline{Y}_{,jk} \right)^{2}} - C \right] \left[ \widetilde{N} \right]$$

The sum of squares of the exposure level X exposure duration interaction (SSDXL) is the variation of the cell means about the grand mean, less the variation already accounted for by the field level factor and the exposure duration factor.

$$SSDXL = \begin{bmatrix} n & q \\ \sum_{i=1}^{n} & \sum_{k=1}^{n} (\overline{Y}_{i,jk})^{2} \end{bmatrix} [\widetilde{N}] - SSD - SSL - C\widetilde{N}$$

Approximate the state of the second of the s

The total error variation is computed as the summation of the variation within each cell about the cell mean.

SSE = 
$$\sum_{j=1}^{p} \sum_{k=1}^{q} \left[ \sum_{i=1}^{n} (Y_{ijk})^{2} - \left( \frac{\sum_{j=1}^{n} Y_{ijk}}{n_{jk}} \right)^{2} \right]$$

The error within subjects is then the total error less the error accounted for by the effects between subjects.

The ANOVA Summary table, Table III, is partitioned into two parts, the effects between subjects and the effects within subjects. The F-ratio obtained by comparing the mean square of the exposure level with the mean square of the subjects within groups is a test for a significant difference in the means of the two exposure levels.

The F-ratio obtained by dividing the mean square of the exposure duration by the mean square of the exposure duration X subjects within groups is used to test for significant dif rences between the means of the weekly samples. The interaction between the exposure level factor and the exposure duration factor is obtained by dividing the mean square of the interaction the mean square of the exposure duration X subjects within groups.

For those cases where the parameters were not normally distributed, a transformation of the data was made prior to the ANOVA analysis. Table VIII in the Results section identifies the applicable parameters and the transformation used.

In the statistical analysis of the data, two sources of variation are of direct interest in making decisions about the effect of the exposure level upon the animal groups. These are the exposure level and the interaction between exposure level and exposure duration. The F-ratio obtained from the exposure level factor can be used to make decisions about the mean differences between the two groups of animals. The interaction can be used to determine whether the two groups responded differently to the exposure duration factor.

The exposure duration factor, however, does not have a direct bearing upon the question of differences in the two groups caused by the field treatment. The time-series records of animals are subject to a number of factors other than the exposure level factor. For example, seasonal variations of blood parameters constitute an additional factor common to both groups but not related to the field exposure.

The exposure level factor assumes that there were no initial differences between the two groups of animals. If the assumption is false, the main effects of the field level are said to be completely confounded with differences between groups.

TABLE III

SUBMARY OF ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	. F.	LL
Between Subjects Exposure Level	(1 - d)	SS	SSL (p-1)	HSL
Subjects Within Groups	d (l - l)	EERB	EERB (n-1)p	
Within Subjects Exposure Duration	(q - 1)	SSD	SSD (q-1)	MSD MSERRW
Exposure Duration X Exposure Level	(p-1) (d-1)	SSDXL	SSDXL (p-1)(q-1)	MSDXL MSERRW
Exposure Duration X Subjects Within Groups	ΣΣnj <sub>k</sub> - p(q+n-1)	ERRY	ERRW EEnjk P(q+n-1)	

A significant F-ratio for the interaction would indicate a difference in the simple effects of the two exposure level factors. That is, the trends of the two groups would be different from each other. When a significant interaction was found, a regression analysis (10) was performed on the paired animal differences to determine whether the relationship was linear or nonlinear.

## Nonparametric Test

The Mann-Whitney U-Test (2) was applied to all of the parameters. For those parameters which were not normally distributed and could not be readily transformed to normal distributions, this was the only statistical test applied to the data.

The Mann-Whitney U-Test is a rank test that produces a Z statistic which can be related to the standardized normal distribution to determine the level of significance.

In this experiment, weekly samples constitute repeated measures and are not independent. For this reason a rank tally scheme as shown in Table IV was used to obtain independent measures to which the Mann-Whitney U-Test could be applied. Each weekly record of the two groups was combined and the combined group ranked. The ranks of each animal for each week were then summed to obtain a rank total for each animal. The resulting rank total for each animal was then ranked and the Mann-Whitney U-Test applied to the final ranking.

For missing values, an average of the lart and next available data point in an animal's weekly samples was used as the missing point. If the missing point was the last value, the last evallable data point was used. Likewise, if a point was missing at the beginning of an animal's record, the next available data point was used.

In the case of ties in ranking procedure, all tied ranks were replaced with an average of the tied ranks. This assures that the ranking of other animals is undisturbed.

#### START-UP PROCEDURE AND SCHEDULE

To assemble a staff sufficient to give sixty physicals, draw sixty blood samples, and in general, collect the same data on all animals on the same day would have increased the cost of the project approximately five-fold. The following schedule was therefore prepared to minimize cost by distributing the workload over a six-week period without losing scientific rigor or compromising the statistical validity of the data. This schedule was designed to allow data on each animal to be taken at the same intervals of exposure. For example, the total exposure time for any animal at his third physical examination was identical to the exposure time for all other animals at their third physical examination. The same was true for all data; for example, the 33rd blood sample for all animals was drawn after the same number of days of exposure.

TABLE IV

RANK TALLY SCHEME FOR MANN-WHITMEY U-TEST

ANIMAL NO.		HEEKS	SUM OF MEEKLY RANK NUMBERS	RANKI NG OF SUMS	SUM OF FINAL RANKINGS
	-	2			
ž	Rank No.	Rank No Rank No.	ZR! Rank Numbers	Rank No. of 281	
<b>R</b> 2	Rank Mo.	Rank No Rank No.	ER2 Rank Mumbers	Rank No. of ER2	
•			•		
•	•	•	١,	•	
	•		•		
•			•	•	
	•				
Rn	Rank No.	Rank No Rank No.	ZRn Rank Numbers	Rank No. of 180	Cree for D
250	Rank No.	Rank No Rank No.	281 Rank Numbers	Bank No of 581	dro la viole inco
<b>B</b> 2	Rank No.	Rank No Rank No.	EB2 Rank Numbers	Rank No. of EB2	
•	•				
•	٠		• 1	1	
				•	
• '			•		
	• •	•	•		
		•	•		
ug u	Rank No.	Rank No Rank No.	18n Rank Numbers	Rank No. 18n	Sum for B Group

On Monday, 27 October 1975, pair number one was brought from the vivarium to the ELF Building. One animal was then placed at position one over the north simulator and the other animal placed in the corresponding position over the south simulator. The staff members placing these animals had no knowledge of which simulator would be energized. The decision to energize a specific simulator was then made by the principal investigator who at that point had no knowledge of which animal had gone to the north of the south side.

Pair one was henceforth designated a Monday pair, which means that every Monday morning blood samples were drawn, cages were changed, and the system was configured to monitor oxygen consumption rate. On Tuesday, 28 October, pair number two was introduced into the experiment and was designated as a Tuesday pair. The procedure continued with one additional pair of animals entering the experiment each weekday for six weeks. During the first seven days, each pair was confined to a restraint chair and blood samples were tak in daily to record possible transient effects.

The clinical state of each animal was established prior to entering the experiment. The first clinical observation after beginning the experiment occurred on day seven at the end of the initial restraint period. This early physical after only seven days of exposure was intended to provide clinical documentation of transient effects. The remaining physicals were at sixweek intervals.

On Monday, 1 November 1976, pair number one had completed 53 weeks in the experiment, and on 10 December pair number 30 had completed 53 weeks. With slight modifications in the protocol, exposure has continued; however, no data taken beyond 53 weeks are included in this report.

#### RESULTS

#### VETERINARY CLINICAL EVALUATIONS

Clinical evaluations were performed on one monkey from each group every weekday as outlined in the protocol. Every animal has now been examined nine times at six-week intervals. Intradermal skin tests for tuberculosis have been accomplished every six months; all results were negative. Each animal also received a dental prophylaxis including ultrasonic calculus removal. A variety of minor conditions have been noted in both groups such as abrasions, regional alopecia, gingivitis, otitis externa, rhinitis, and hematomata. These conditions are frequently encountered in most rhesus monkey colonies.

Bacterial enteritis is a common disease in rhesus monkeys. As a part of the selection process all animals were screened and found negative for enteric pathogens by rectal swab and culture. Despite this precaution, pathogenic bacteria have subsequently been isolated from four animals. One monkey became clinically ill with blood-tinged diarrhea. Salmonella enteritidis was isolated by rectal swab. Antibiotic therapy was effective in alleviating symptoms, but the animal has remained a subclinical carrier. Shigella flexner was isolated from a routine fecal culture of another monkey. This animal was symptomless. Antibiotics were administered in an unsuccessful attempt to eliminate the carrier state. Two other animals were also found to have positive cultures for Salmonella enteritidis but were asymptomatic. The three Salmonella enteritidis carriers were in the control group and the Shigeila flexner carrier was in the experimental group. Identification of these cultures was confirmed by the Center for Disease Control in Atlanta, Georgia. Special feeding, watering, and handling techniques were initiated for these animals, and the absence of additional cases attests to the effectiveness of these measures.

For seven consecutive days during each six-week cycle for a total of 31 weeks the monkeys remained in plexiglass restraint chairs. During the initial cycle approximately 50% of the animals developed edema in one or both lower extremities while in the chairs. The animals had all been conditioned prior to the experiment by daily chair sessions beginning with a one-hour period and increasing the time up to six hours. No edema developed during this conditioning. A translent panleucocytosis usually accompanied the more severe cases of edema, and often persisted several days after the animal was removed from the chair. The edema usually disappeared within 48 hours. It was discovered that the plexiglass seats were restricting venous return from the legs, as the animals were seated on plexiglass blocks with abrupt 90 edges. In addition, it became evident that the height of the seat above the foot rest had to be adjusted to insure that the rump was lower than the knees. A new seat of contoured, fiberglass reinforced plastic was designed and it eliminated the problem.

Two animals from the control group have died since the experiment began. One monkey developed acute gastric dilatation while in a restraint chair. Approximately 1000 ml of fluid and undigested food were withdrawn by naso-gastric tube. Despite intensive resuscitative efforts the animal died several hours later. Necropsy revealed a greatly distended stomach with hemorrhage and necrosis over the entire greater curvature of the The etiology is not certain; but gastric overload with food and water during periods of restraint is suspected. A second monkey was found comatose after 24 hours in a closed-system chamber. Treatment for shock was begun immediately, but the animal died two hours later with clinical evidence of pulmonary edema. Post-mortem findings included pulmonary edema and hepatic central lobular necrosis. The chamber atmosphere contained a contaminant gas which has been determined to be methy! methacrylate monomer. This chemical was used to seal cracks in the plexiglass. The monomer is normally oxidized to an inert polymer. In this case the oxidizing compound did not fully polymerize the methyl methacrylate, resulting in an accumulation of the volatile monomer in the closed system. Personal communication with environmental health officials confirm that the compound is considered highly toxic and produces pathologic changes as found in this case. The National Animal Disease Laboratory attempted unsuccessfully using gas chromatography to recover the compound from a liver tissue sample.

Systolic blood pressures were determined during each physical evaluation cycle. Pressures were measured indirectly from the ulnar artery using a pediatric sphygmomanometer cuff and a Doppler ultrasonic flowmeter. Measurements were taken with the monkey seated in the plexiglass restraint chair as shown in Figure 8. Means and standard deviations are shown in Figure 9. It should be noted that the mean values of the two groups are similar and tend to decrease with time. The variation within groups increases as reflected by higher values for standard deviation. A possible explanation may be that some of the animals became highly conditioned to the chair and examination procedure and remained more tranquil during the data acquisition.

Ages as determined by dentition are subject to a fairly substantial error due to variations in tooth eruption dates. For example, the lower second molar erupts from 43 to 59 months, and the next tooth to erupt is the lower third molar at approximately 80 months. The third upper molars erupt at 90 months. Therefore, there can be a gap in aging data from 59 to 80 months and from 80 to 90 months of age. After 90 months of ago, dentition is a less valuable criterion for aging monkeys. The average age at selection was 48.3 months for the experimental group and 47.1 for the control group. The average age of the females at selection was 51.5 months for the experimentals and 50.9 for the controls. The average age of the males at selection was 44.6 for the experimentals and 42.8 for the controls. At six month intervals during the project the age was estimated again without being blased by knowledge of the previous estimate. At the end of the first year, the average age of the total experimental group was 69.2 months and for the control 69.8 months. The average age for the

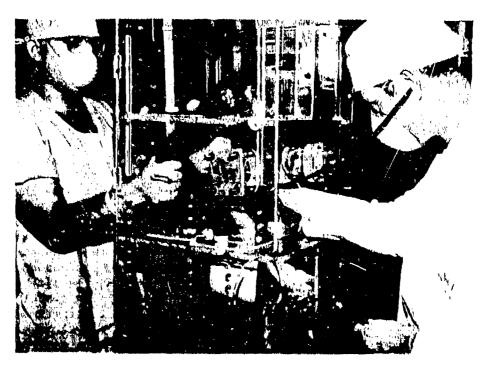


FIGURE 8. Physical examinations were done with the animals restrained in plexiglass chairs.

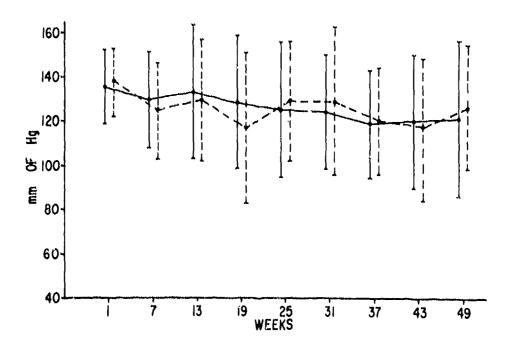


FIGURE 9. Means and standard deviations of systolic blood pressure.

females was 68.2 for the experimentals and 69.1 for the controls. The average age for males was 70.2 for the experimentals and 70.6 for the controls. These data demonstrate the age estimation errors, in that over a 17 month period the males appear to have aged 26.7 months, while the females aged 17.5 months; however, age estimation for the experimental group compares well with the corresponding estimation for the controls at both the time of selection and at the end of the first year.

A set of standard body measurements were taken at the time of selection (June and July 1975) and at six month intervals during the exposure period. These data are summarized in Tables V and VI and show that at the end of one year the exposed males were larger than the control males in body weight (P=0.07), chest circumference (P=0.08), and body surface area (P=0.10). The same standard measurements were used to compute the gain in body measurements as shown in Table VII. These calculations confirm that the exposed males grew more than the control males. The significance level for chest circumference decreased (P=0.19) because this measurement for the exposed males was slightly larger initially. The significance level for body weight gain increased (P=0.001) because the weight gain analysis is less sensitive to the initial and final distributions of body weights. The significance level of the body surface area increased because this measurement is calculated from the following equation (9) in which body weight predominates:

BSA (square cm) - Weight (kg) 0.6046 X Crown Rump (cm) 0.1862 X 514

This difference in growth rate for the males was also confirmed by the analysis of variance computation on the weekly measurements of body weight that are plotted in section IIIC.

## **BLOOD CHEMISTRY PLOTS**

Blood chemistry data are plotted as means and standard deviations for those parameters that were normally distributed. Other parameters are plotted as medians with interquartiles.

The exposed group is designated as "File 1-30" and the control group designated as "File 31-60". Files 1-30 are for the R group and files 31-60 are for the B group. Corresponding data points for these two groups were slightly separated on the time axis to allow standard deviation and quartile lines to be readily distinguishable.

Blood chemistry data for the first six days of the experiment in which blood samples were drawn every day are plotted separately and the units on the axis are in days. The data point for day six is the same as the data point for week one in the weekly plots. In the weekly plots there is a designation indicating that files 6, 36, 20, and 50 were excluded. This means that the data for animals R6, B6, R20, and B20 were not included in the calculations for those plots. They were excluded because animals B6 (female) and B20 (male) died (B6 on 22 Dec 75 and B20 on 21 Feb 76) for reasons that are discussed in the clinical section. To maintain a matched group it was necessary to exclude data from the

TABLE V

MALE BODY MEASUREMENTS

		BE:	BEFORE EXPOSURE		MO	AFTER SIX	AFTER SIX MONTHS EXPOSURE			AFTER YEAR EX	AFTER ONE YEAR EXPOSURE	
	Exposed	sed	Control	lo	Exposed	sed.	Control	0.1	Exposed	sed	Control	0.
	Nezn	SD	Mean	SD	Hean	SB	Mean	SD	Kean	SD	Mean	20
CROWN - SOLE (cm)	71.2	4.2	72.1	4.3	78.1	3.7	77.6	1.4	79.9	2.9	80.0	3.5
CROWN - RUMP (cm)	46.9	2.7	47.2	2.9	51.1	~. &.	50.5	3.3	52.4	1.4	52.4	2.6
SKULL CIRCUMFERENCE (cm)	27.4	1.2	27.6	1.2	29.2	1.2	28.7	-:	30.1	1.6	30.2	2.0
CHEST CIRCUMFERENCE (cm)	34.4	3.5	33.4	2.5	35.1	3.2	33.8	8:	39.9	2.8	37.9	œ. -
BODY SURFACE AREA (square cm)	2831.0	375.0	375.0 2830.0 373.0	373.0	3347.0	354.0	3347.0 354.0 3208.0 306.0	306.0	3868.0	368.0	3868.0 368.0 3578.0 343.0	343.0
80DY WEIGHT (kg)	5.2	:	5.2	1.0	6.7	gum g gumb	6.1	1.0	4.8	1.3	7.5	1:1

TABLE VI

FEMALE BODY MEASUREMENTS

		BEF	BEFORE EXPOSURE		MON	AFTER SIX ITHS EXPOSI	AFTER SIX MONTHS EXPOSURE			AFTEI	AFTER ONE YEAR EXPOSURE	
	Exposed	sed	Control	lo.	Exposed	ed	Control	<u>ة</u>	Exposed	sed	Control	2
	Mean	SD	Mean	SD	Mean	SD	Mean	SO	Mean	SD	Mean	SD
CROWN - SOLE (cm)	71.9	2.6	71.0	3.3	74.3	2.5	73.9	3.1	74.1	2.4	74.5	2.3
CROWN - RUMP (cm)	47.1	2.0	9.94	2.1	48.6	1.5	48.7	1.8	48.9	8	0.64	4.1
SKULL CIRCUMFERENCE (cm)	26.7	0.8	26.3	0.	27.0	1.2	27.4	=	27.5	1.6	27.8	1.6
CHEST CIRCUMFERENGE (cm)	33.1	6.1	32.5	1.0	32.9	8.	33.1	1.9	35.2	3.6	36.2	2.1
BODY SURFACE AREA (square cm)	2733.0 210.0 2704.0 217.0	210.0	2704.0	217.0	2882.0 248.0 2887.0 225.0	0.842	2887.0	225.0	3140.0 338.0 3167.0 244.0	338.0	3167.0	244.0
BODY WEIGHT (kg)	4.8	0.5	<b>6.</b> 8	0.5	5.2	9.8	5.3	5.3 0.6	6.1	6.1 1.1	6.1	8.0

TABLE VII

GAIN IN BODY MEASUREMENTS FROM BEFORE EXPOSURE TO AFTER ONE YEAR EXPOSURE

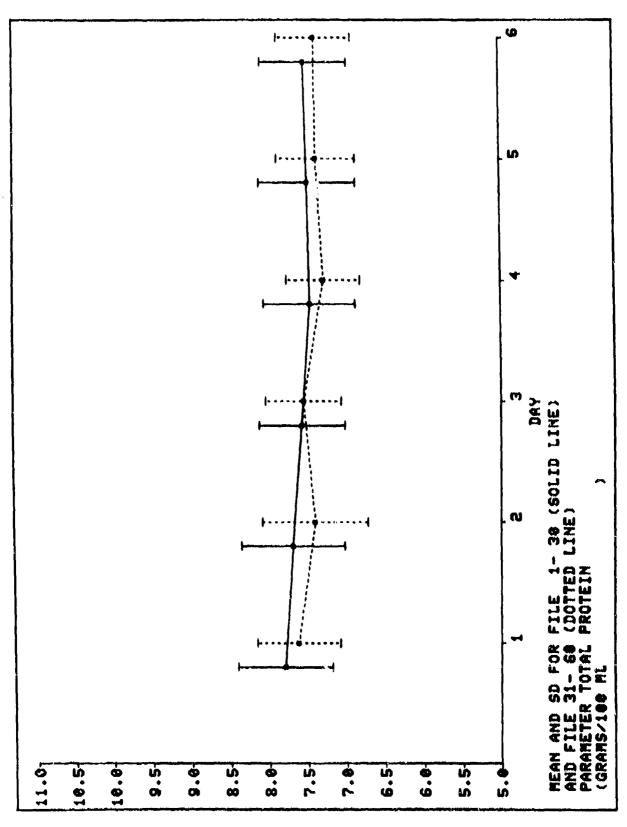
	EXPOSED	SED	CONTROL	ROL	T STA FOR TW	T STATISTIC FOR TWO MEANS
	Mean	SD	Mean	OS .	D£	ಕ
MALES						
Crown Sole (cm)	8.09	3.46	8.0	3.33	233	<u>4</u> ,8
Skull Circumference (cm)	2.45	1.05	2.59	1.41	23	.78
Chest Circumference (cm)	5.53	1.92	4.42	2.12	23	.19
Body Surface (square cm)	1001.2	151.9	766.7	184.1	73	.002
Body Weight (kg)	3.8	0.47	2.29	0.51	7	
FEMALES						
Crown Sole (cm)	2.21	1.95	3.49	2.24	<b>78</b>	=
Crown Rump (cm)	3.03	1.20	3.99	2.93	7 <u>8</u>	. 25
Skul! Circumference (cm)	.79	1.02	1.49	1.41	<b>78</b>	<u>.</u>
Chest Circumfer€nce (cm)	2.08	3.53	3.77	2.69	<b>2</b> 3	.15
Body Surface (square cm)	430.6	285.8	462.9	231.2.	% % %	.73
Sody weight (kg)	07:1	7.	7:		ì	•

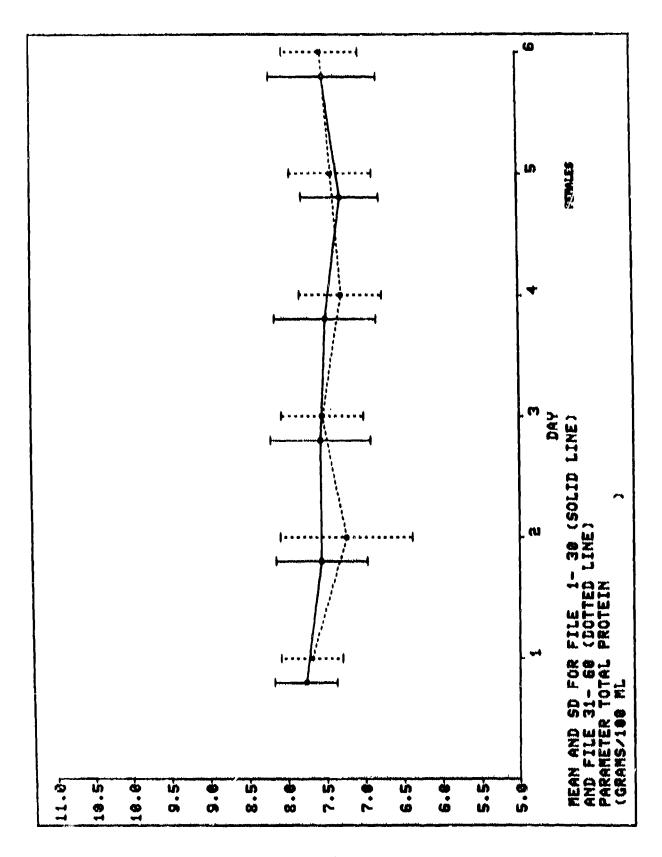
corresponding animals in the R group, R6 and R20. The cages occupied by B6 and B20 were filled within 24 hours after these deaths by replacement animals that were closely matched to R6 and R20. These replacement animals were not intended to provide valid data, but rather to keep the other B group animals from having empty cages in their row and also to maintain the work routine of the staff. These replacements may ultimately provide useful data but such data must be treated carefully to maintain statistical validity.

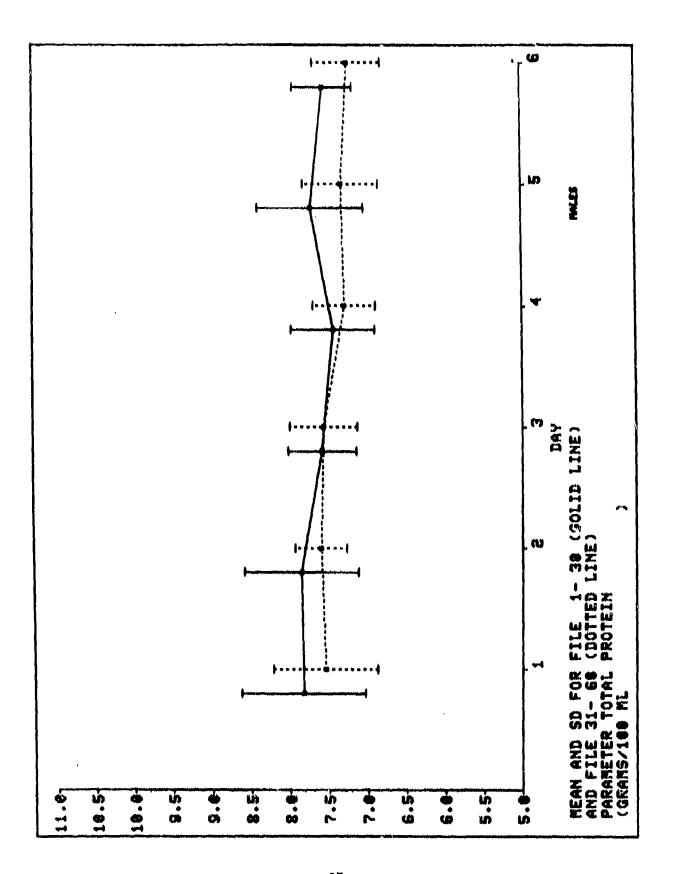
In general, the plotted data are self-explanatory. In some cases it is necessary to recall specific details of the protocol. For example, the animals were restrained for the first days of the experiment and blood was drawn daily; some parameters, especially hematocrit and hemoglobin, were affected by this frequent blood drawing. The animals were restrained again at six-week intervals; data points corresponding to the first, seventh, thirteenth, nineteenth, twenty-fifth, and thirty-first weeks were analyzed from blood samples drawn after the animal had been restrained for six days. Some parameters, especially triglycerides, show cyclic variations that correlate with this restraint period and can be clearly seen on the plots.

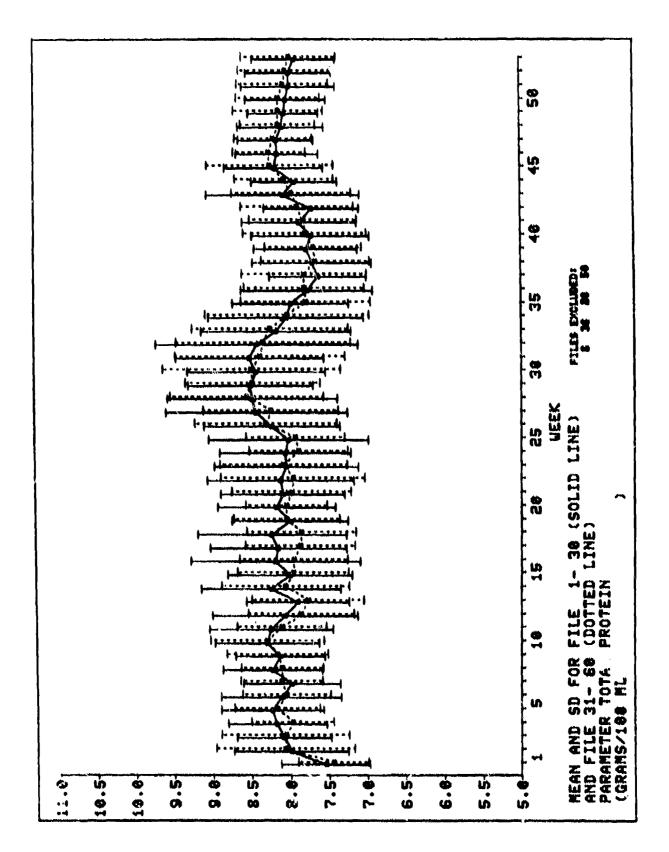
These cyclic variations associated with the restraint period were unexpected. The investigators were not aware of this effect until the data had been plotted for 24 weeks of exposure. It was decided that these artificially imposed effects might possibly mask a field effect and that the benefits derived from the chair protocol were not sufficient to justify this risk; therefore, the chair protocol was discontinued. The last blood sample drawn under restrained conditions was for week 31.

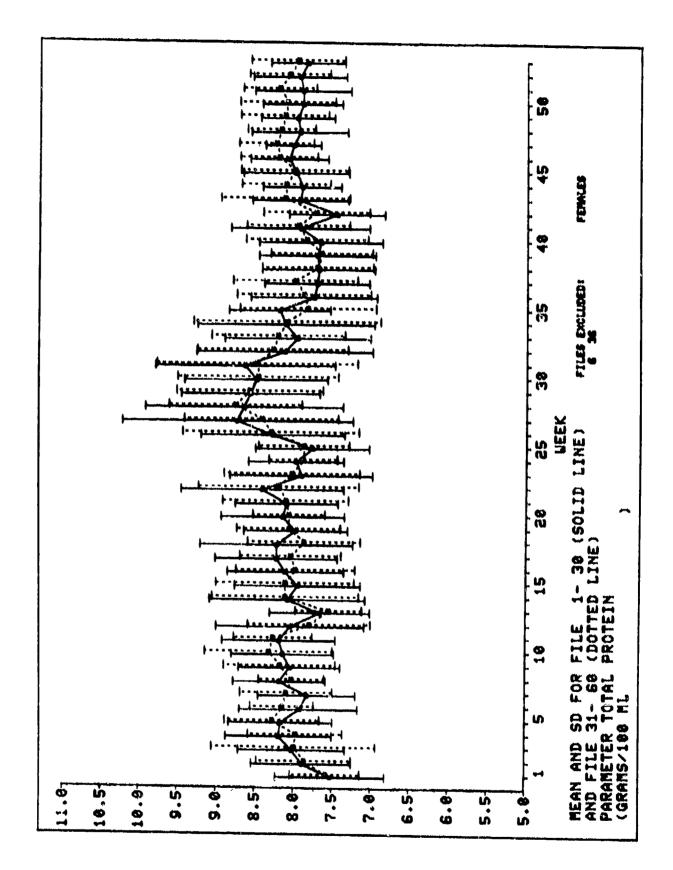
It is also helpful to remember that a given data point on the time line does not mean that all raw data contributing to that data point were taken on the same calendar day; however, they were taken after the same number of days of exposure. For example, the contribution of animal B1 to a given data point occurred six weeks before the contribution of B30. This means that an unusual event that might cause an artifact, such as equipment failure on a given day, would affect only one pair of animals contributing to a specific data point. This same argument applies to the analytical laboratory; the total samples contributing to a specific data point were analyzed over a six-week period. In summary, a significant change in the data represents an influence that must have been consistently applied for a long period.

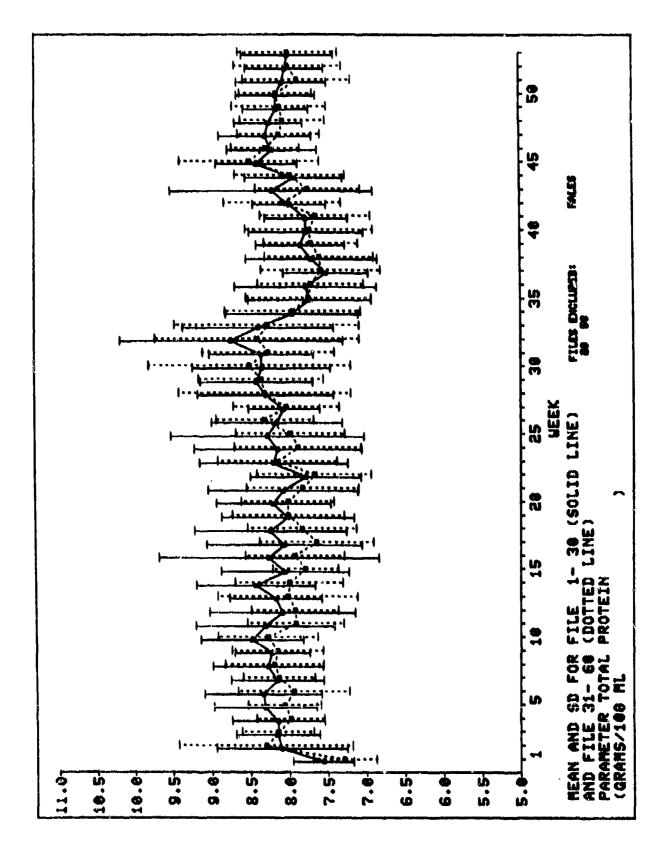






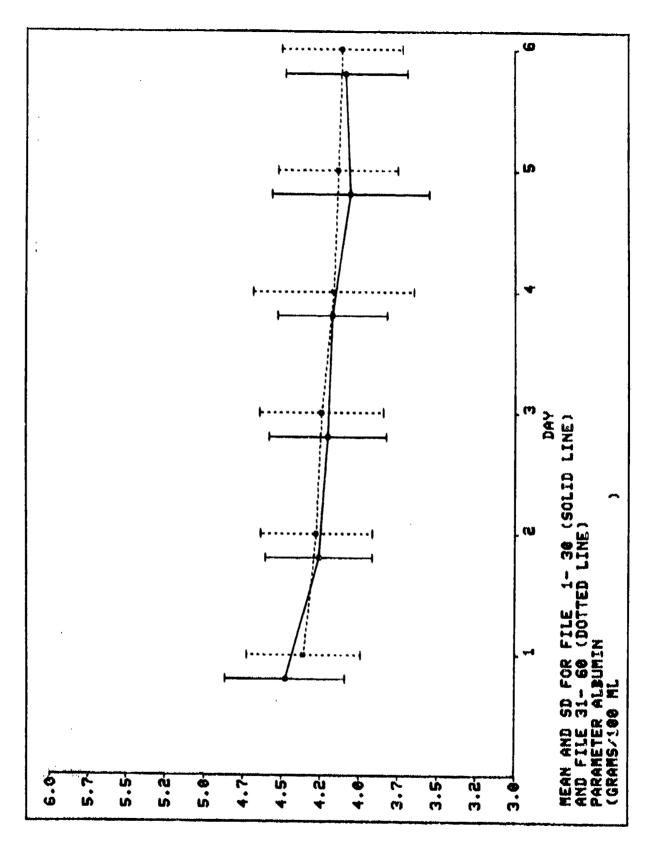


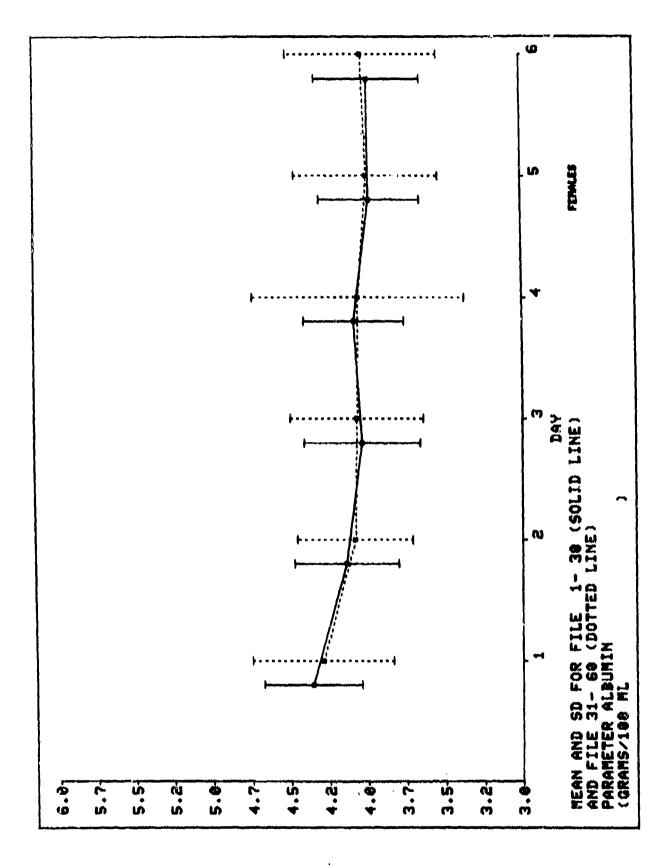




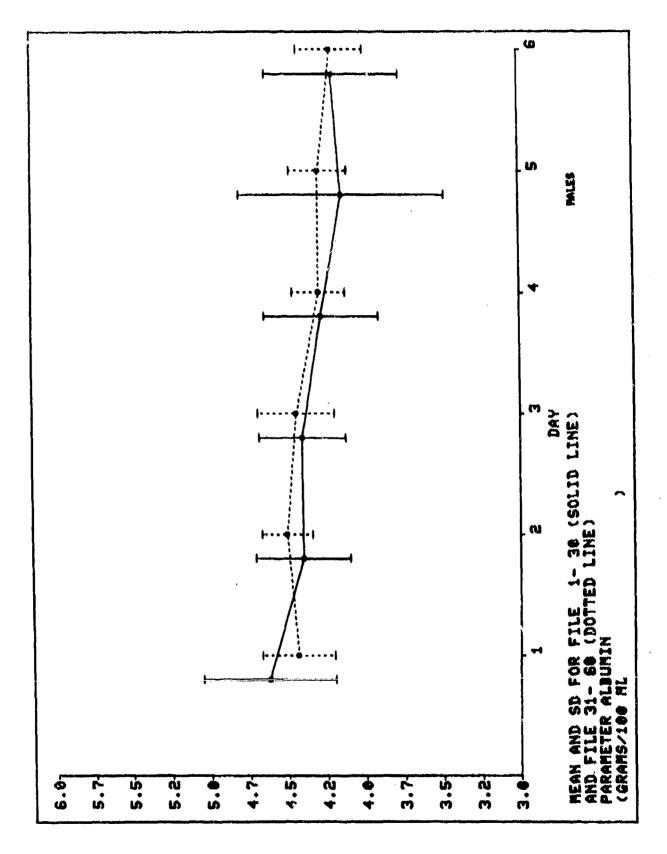
<u>A Cart Marie and Alaid abanda mand damada nami</u>a an ad damada na a bana da Andrea da Andrea a tanda namida na ad damada na ada damada

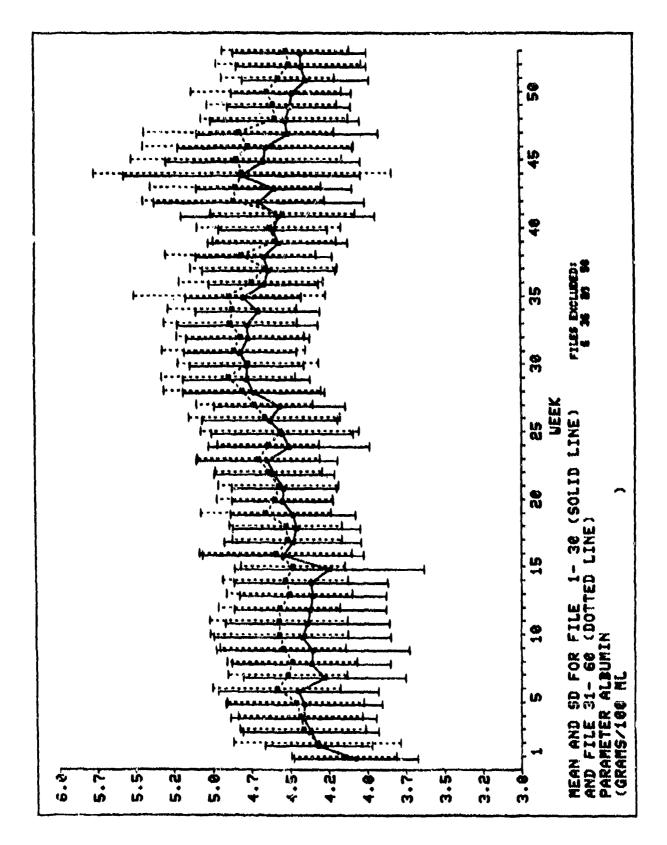
 $\frac{\mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j}}{\mathbf{w}_{i,j} \cdot \mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j}} = \mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j} \cdot \mathbf{v}_{i,j}$ 





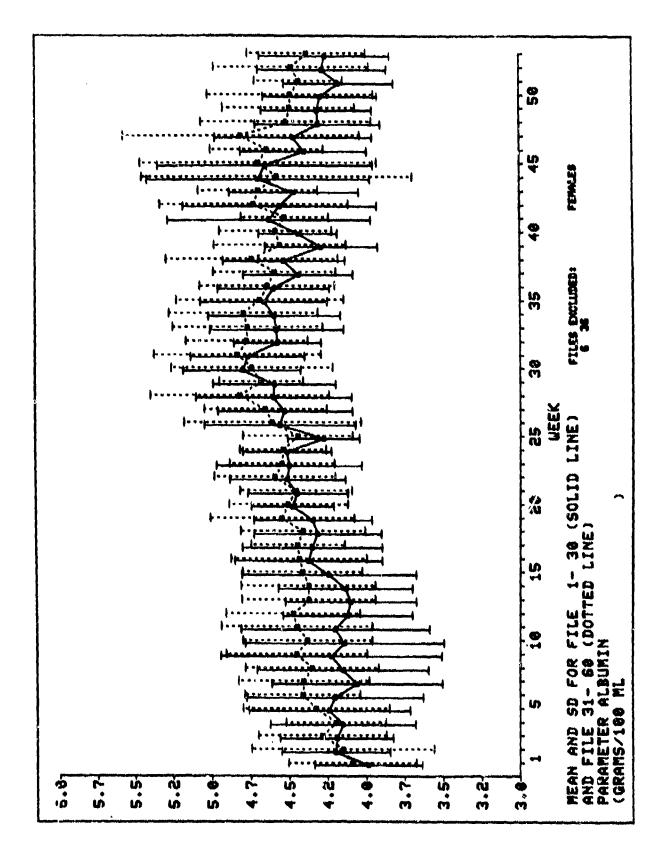
an Andrew Control



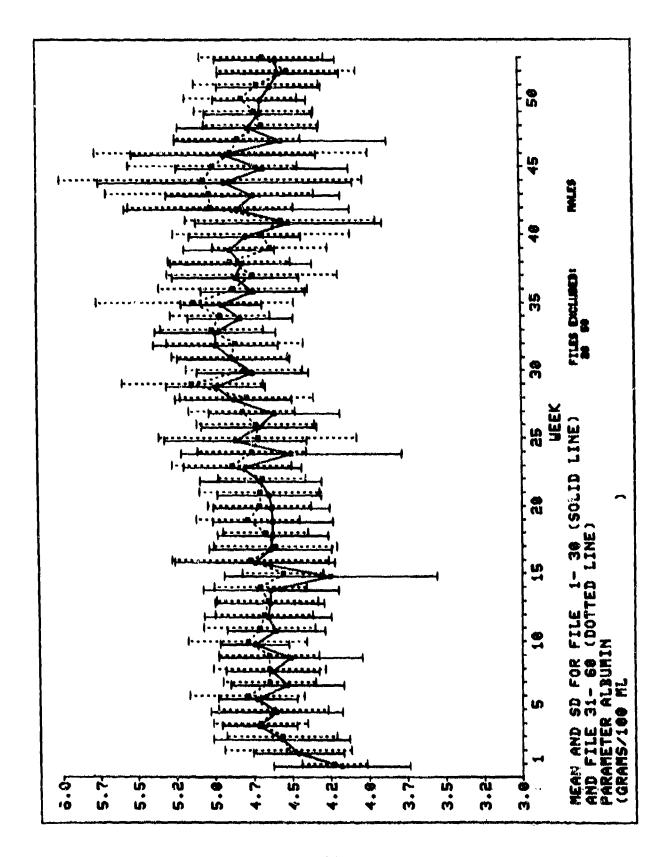


Market of the large last was a first and the contract of the contract of the first of the first

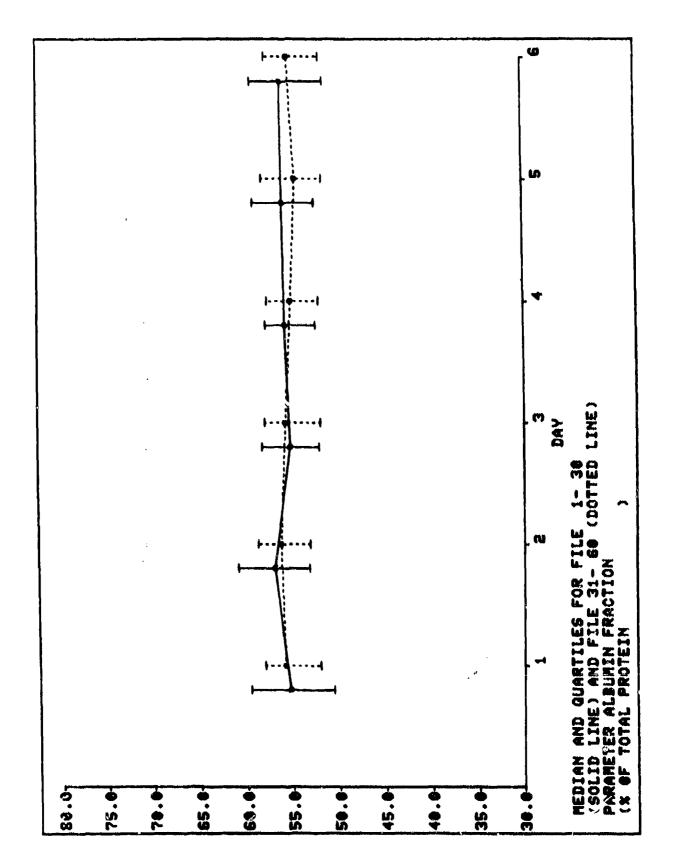
A MAN GARAGE STREET OF THE PARTY

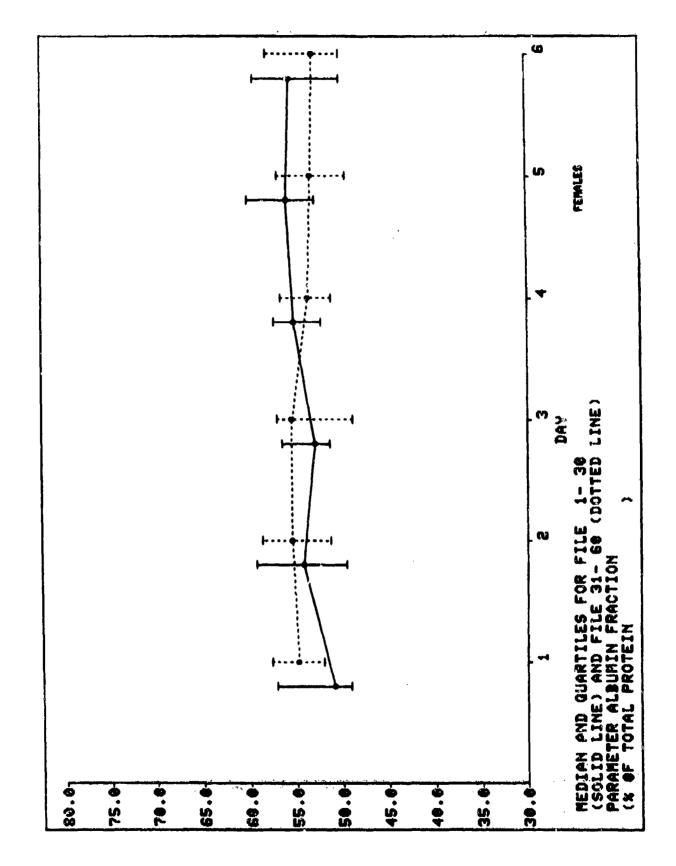


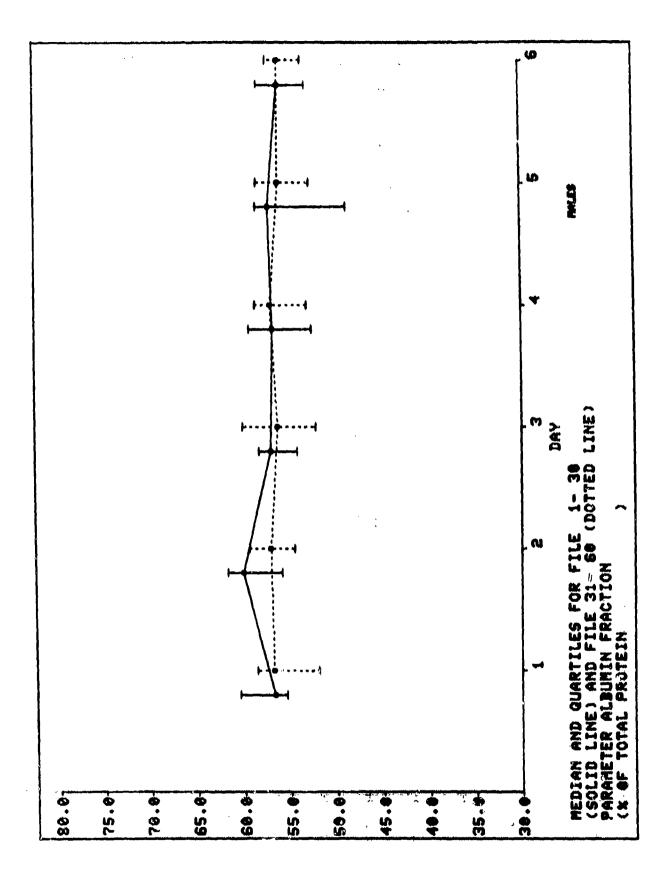
<u>and the first and the tile of the control of the first o</u>

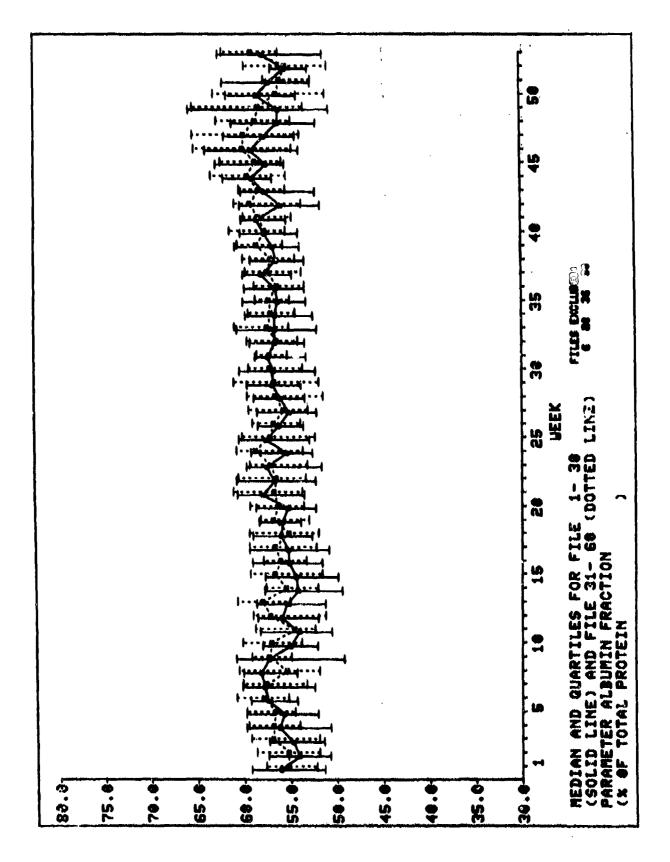


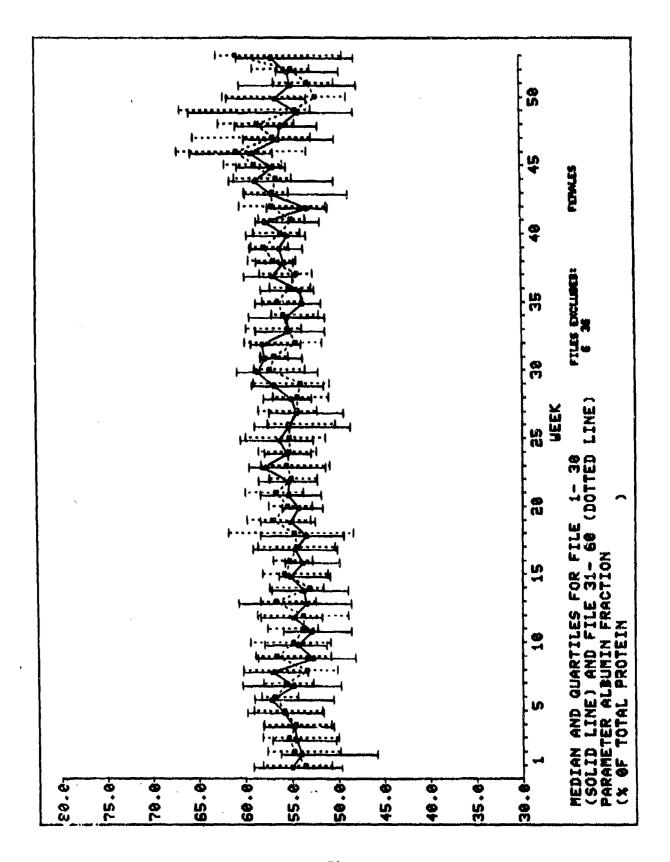
The State of the S

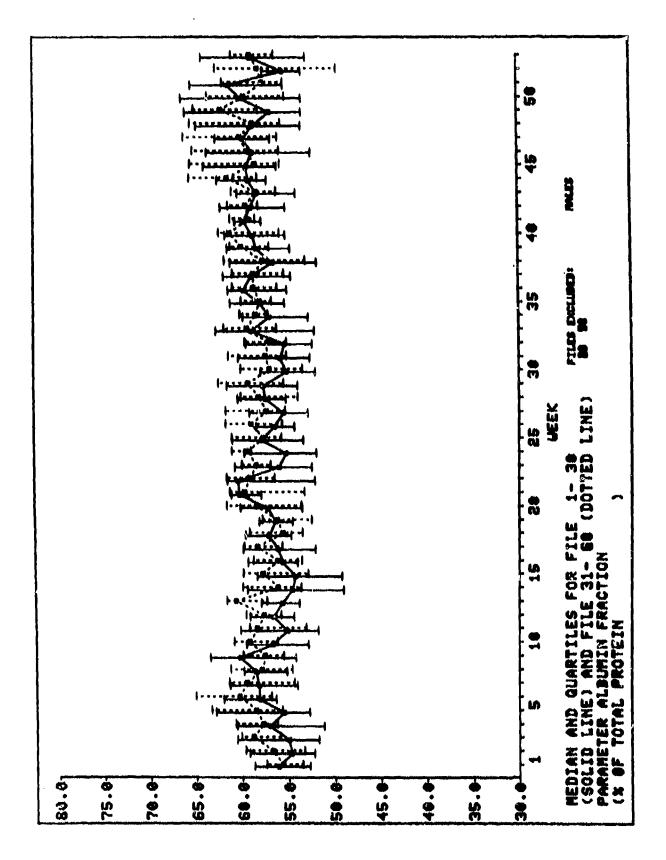




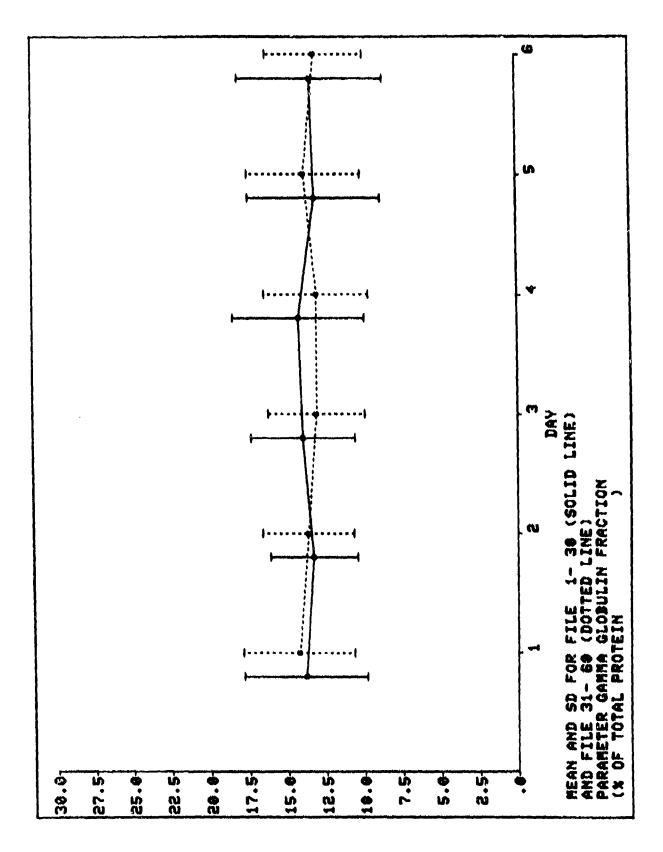




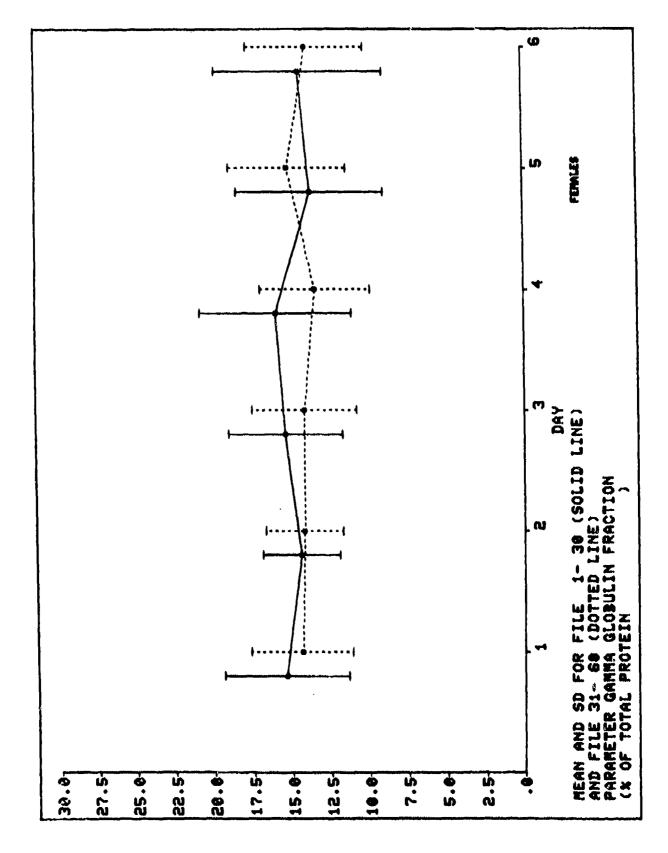




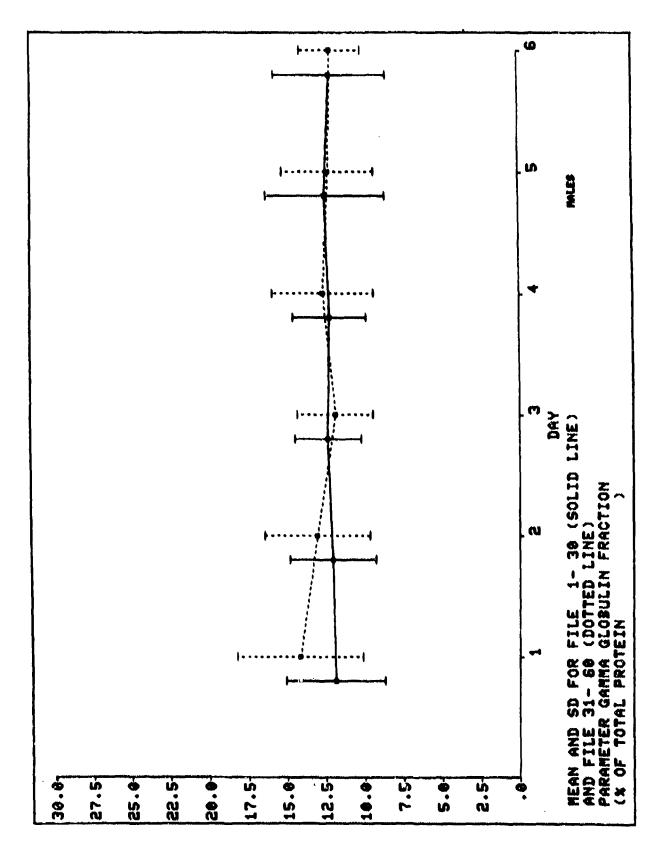
 $\frac{\partial \mathcal{L}_{\mathcal{A},\mathcal{A}}}{\partial \mathcal{L}_{\mathcal{A},\mathcal{A}}} = \frac{\partial \mathcal{L}_{\mathcal{A},\mathcal{A}}}{\partial \mathcal{L}_{\mathcal{A},\mathcal{A}}} \frac{\partial \mathcal{L}_{\mathcal{A}}}{\partial \mathcal{L}_{\mathcal{A}}} \frac{\partial \mathcal{L}_{\mathcal{A},\mathcal{A}}}{\partial \mathcal{L}_{\mathcal{A},\mathcal$ 



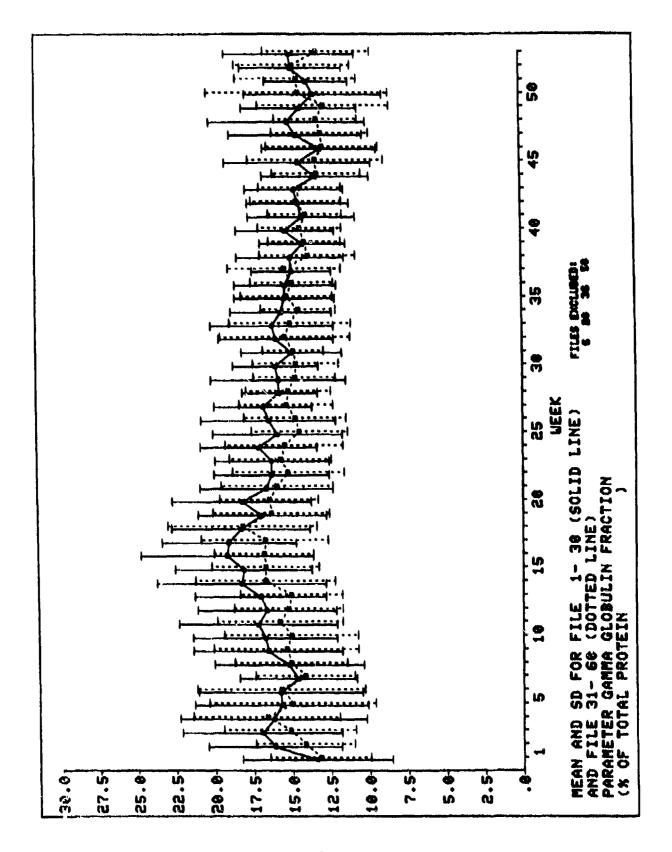
<u> San Mahara Panta da da mahara mahara mahara mahara da mahara mada la mahara da hara da mahara da mahara da m</u>



And the second

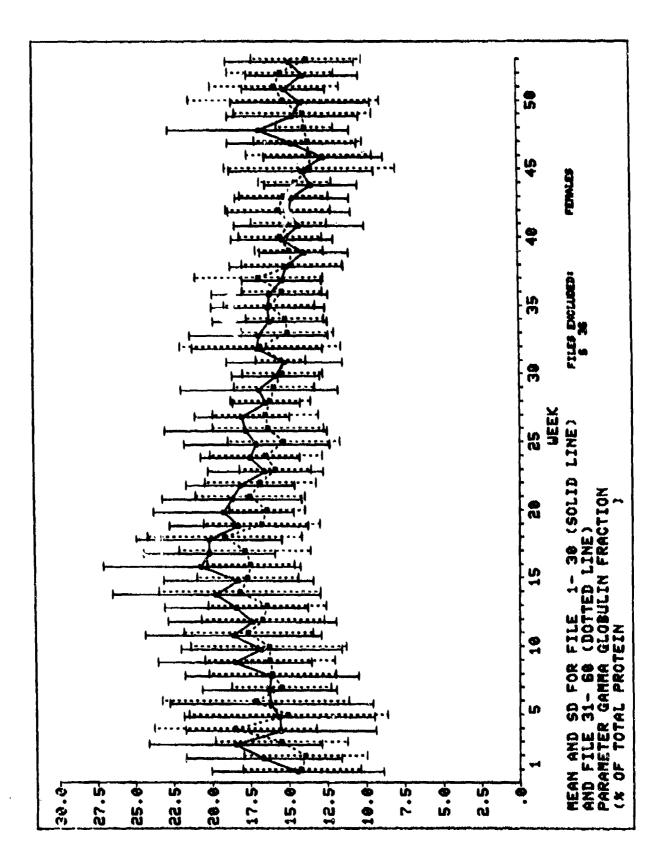


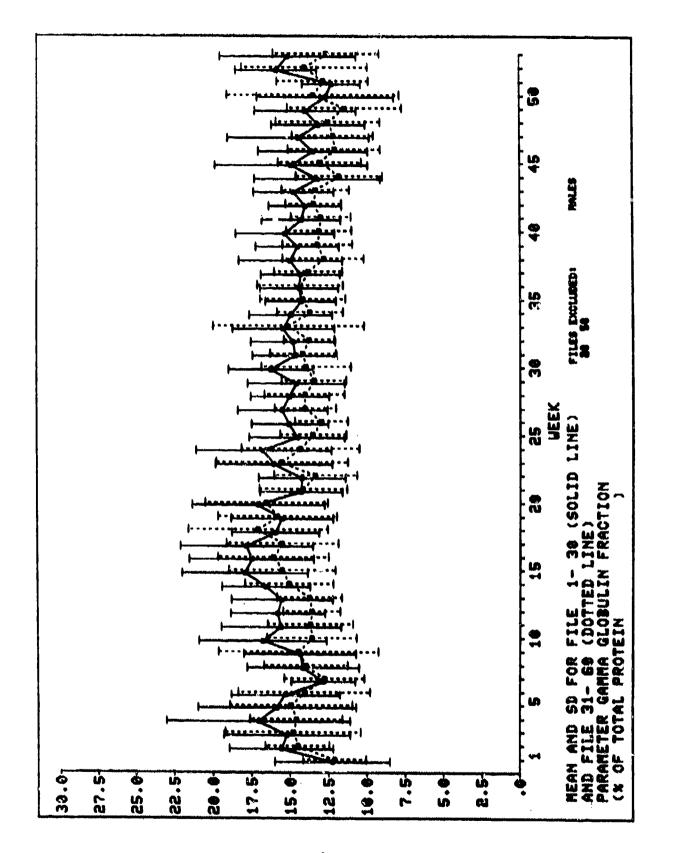
<u> attitud filmingation mirror til så den da histlinda i tallet. I en elektrikli skaltin så i de så kalletinan blas s</u>



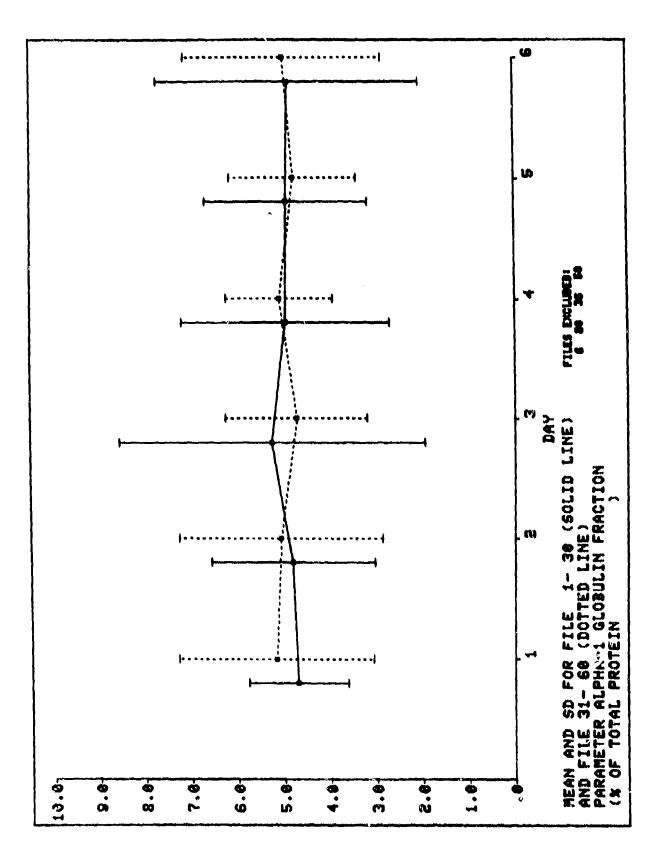
et alleger and the second of the second of the second and the seco

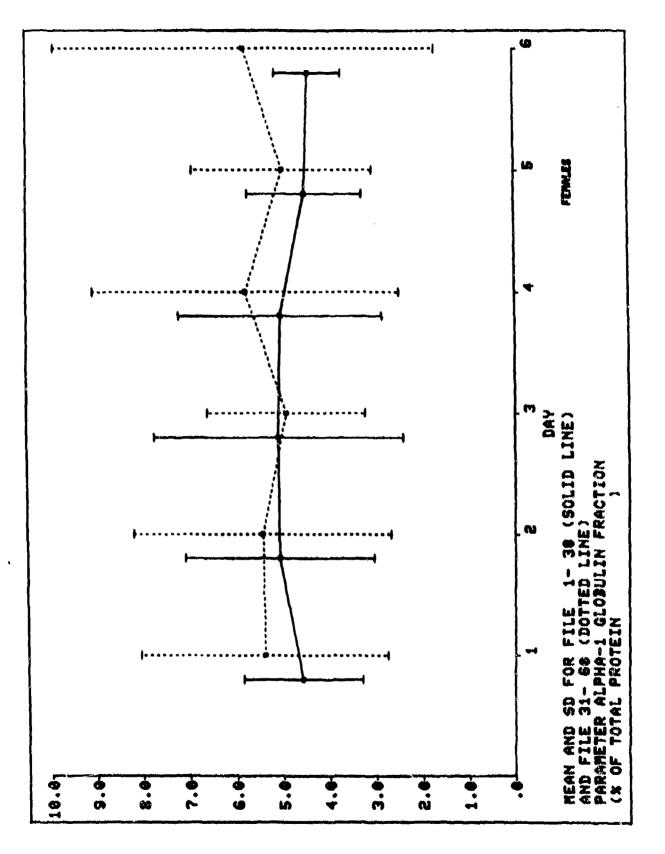
Section Company



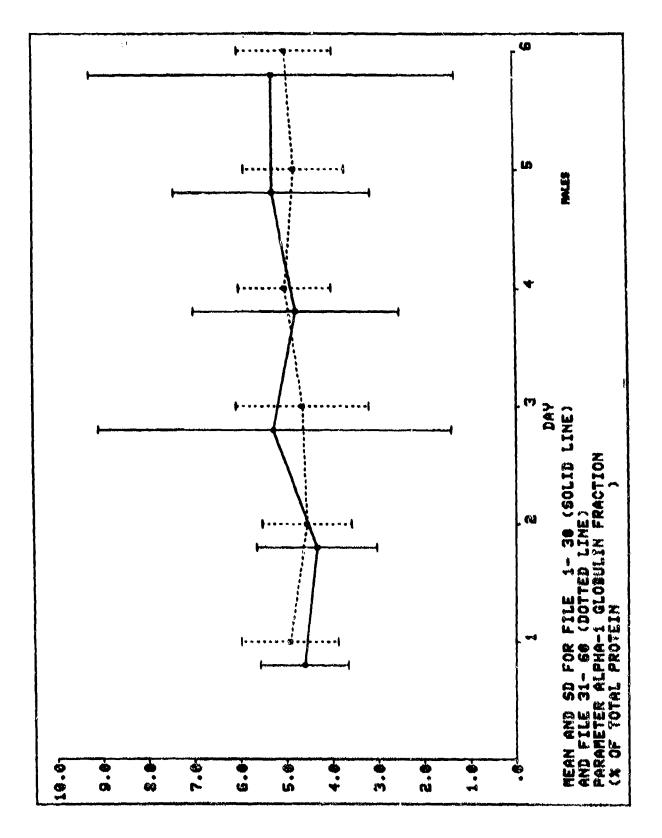


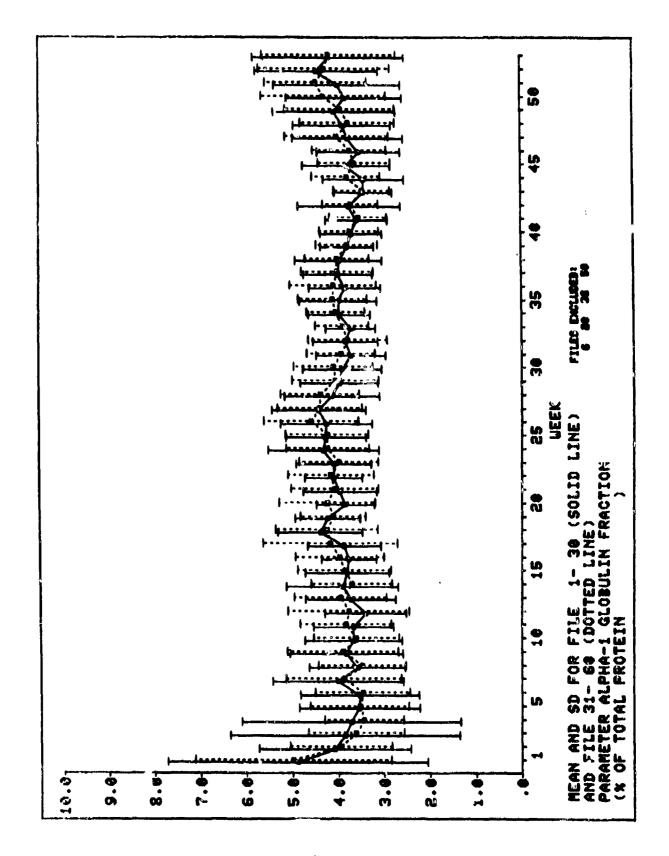
Both Sha his

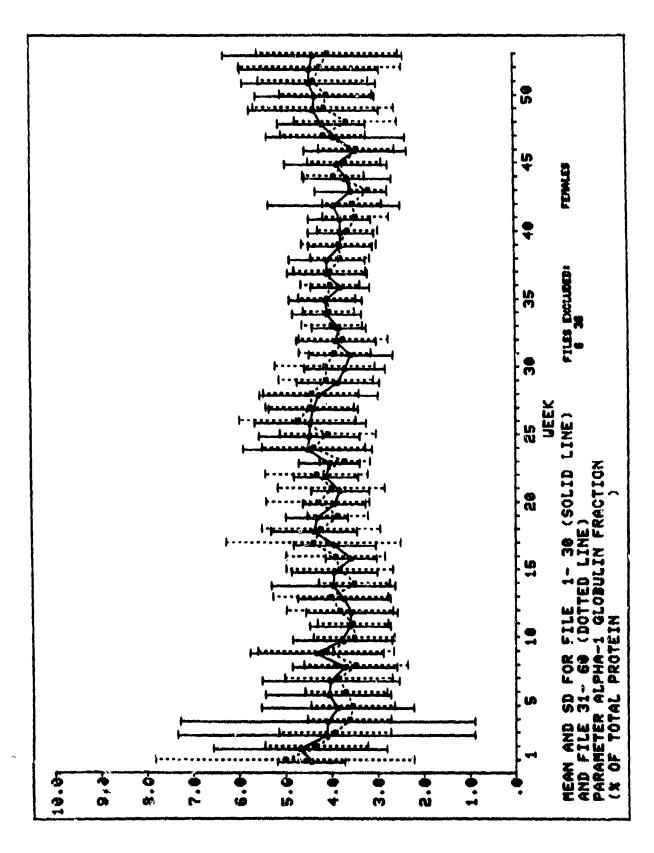




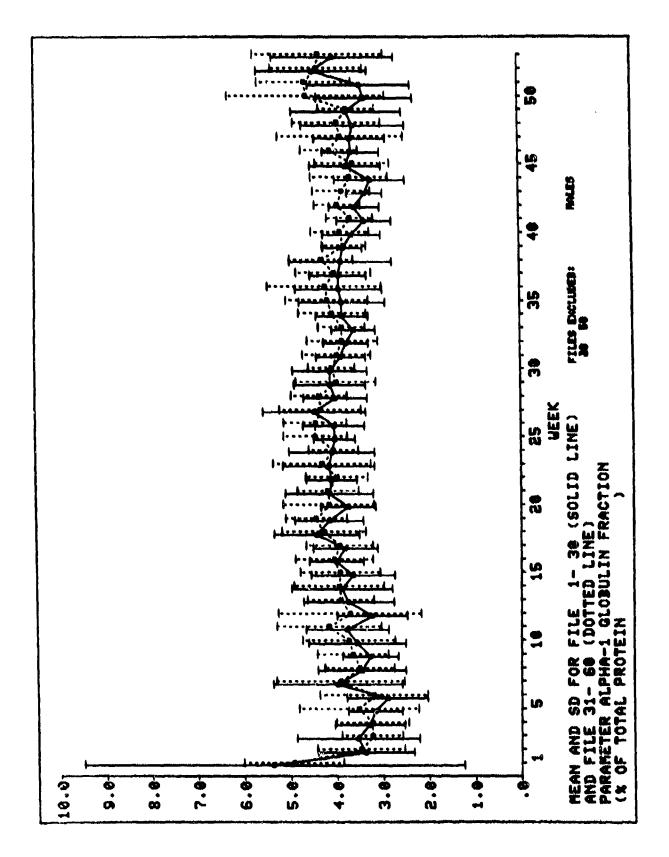
James Commence



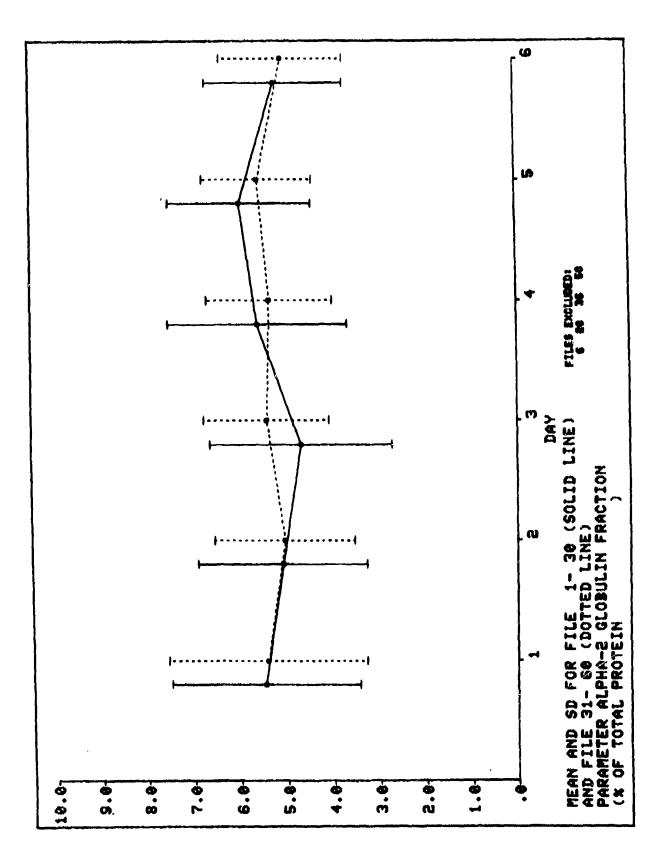




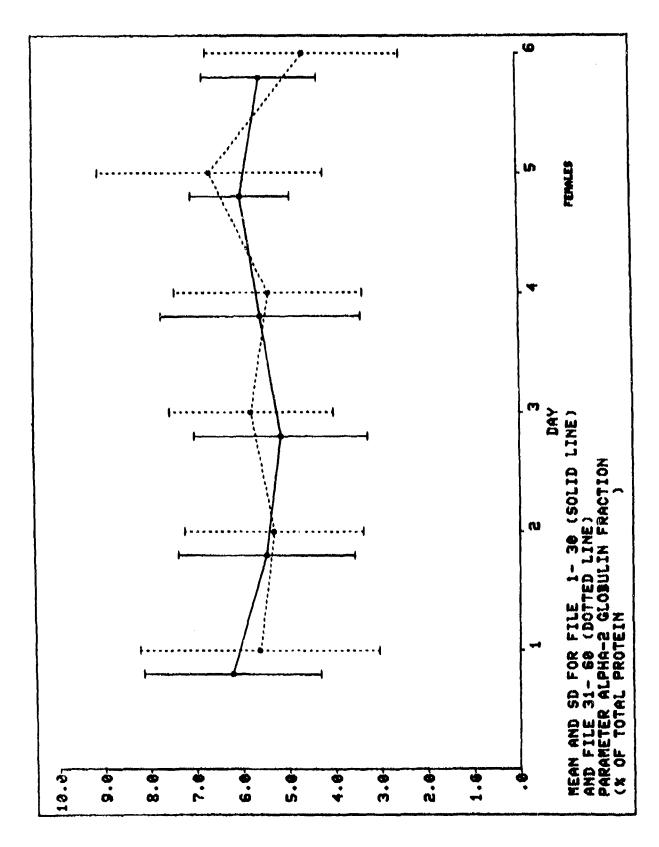
Will have been been to the contraction of the contr



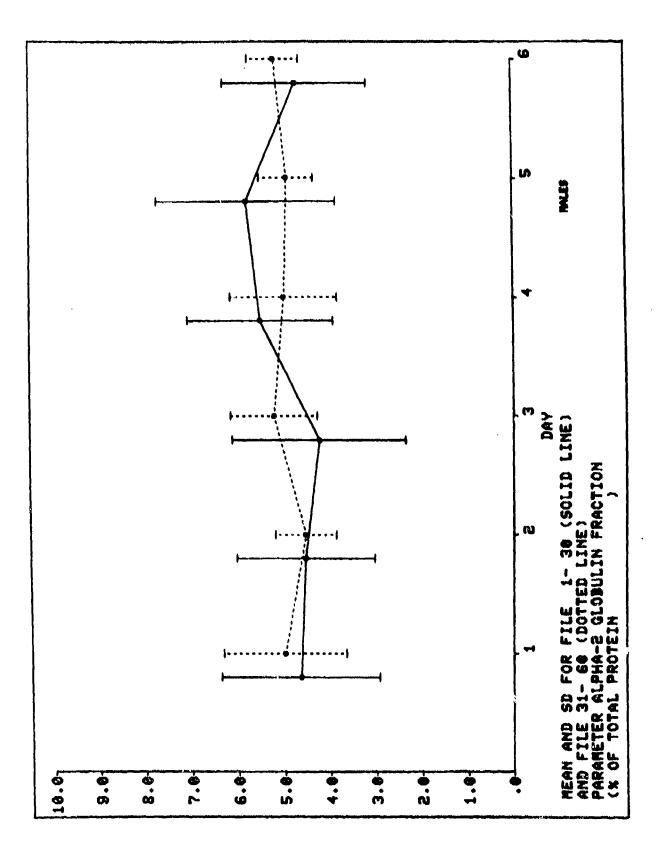
Sing the state of the state of



日の時の場合というとなる

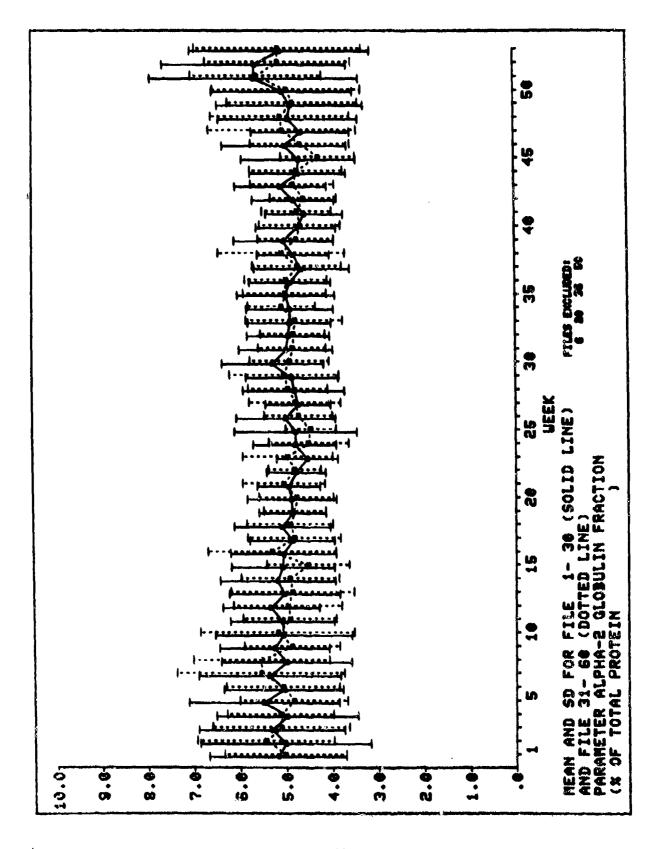


Bernalden in

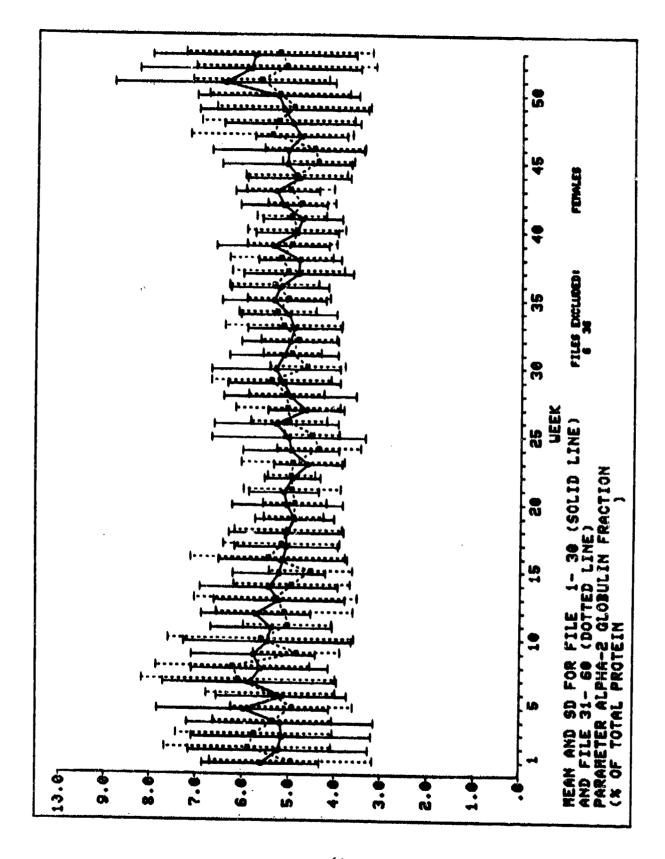


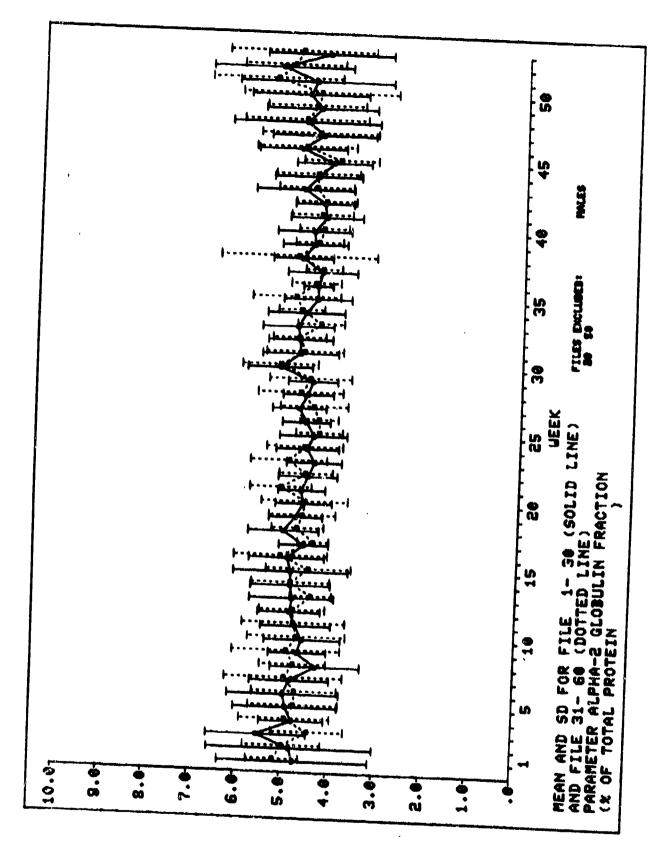
ne van die 1800 Marie 1800 mai 1800 and 1800 mai 1800 mai

こうと あく という といいか といいか ひという でんかい ななおから 地震のは のである はんかい かんない かんしん しょうしょう

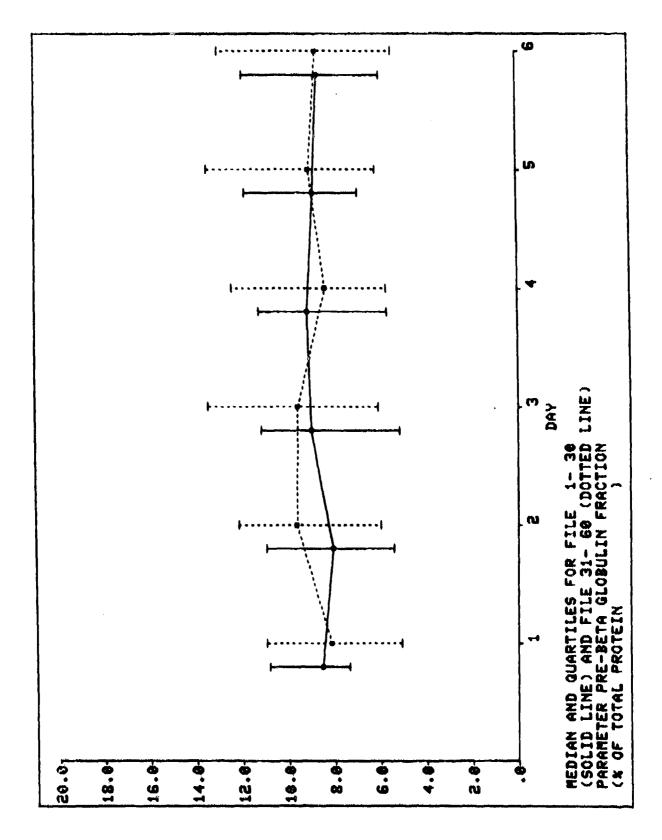


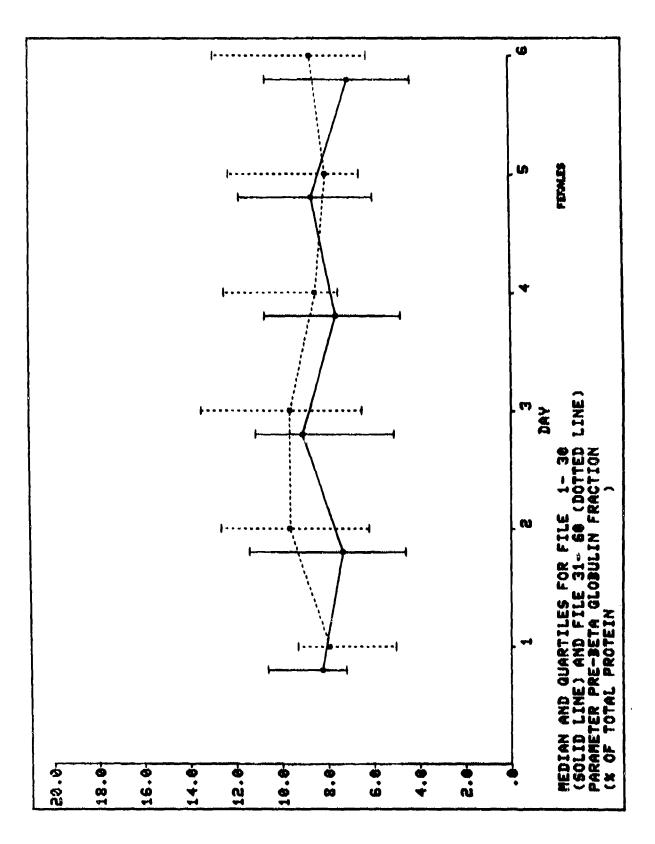
But And Burney Stone

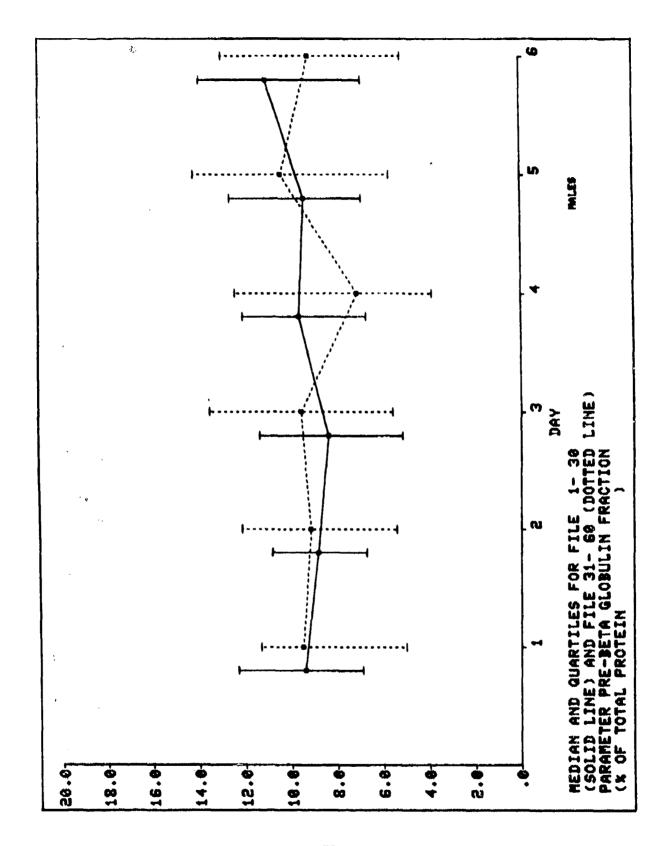


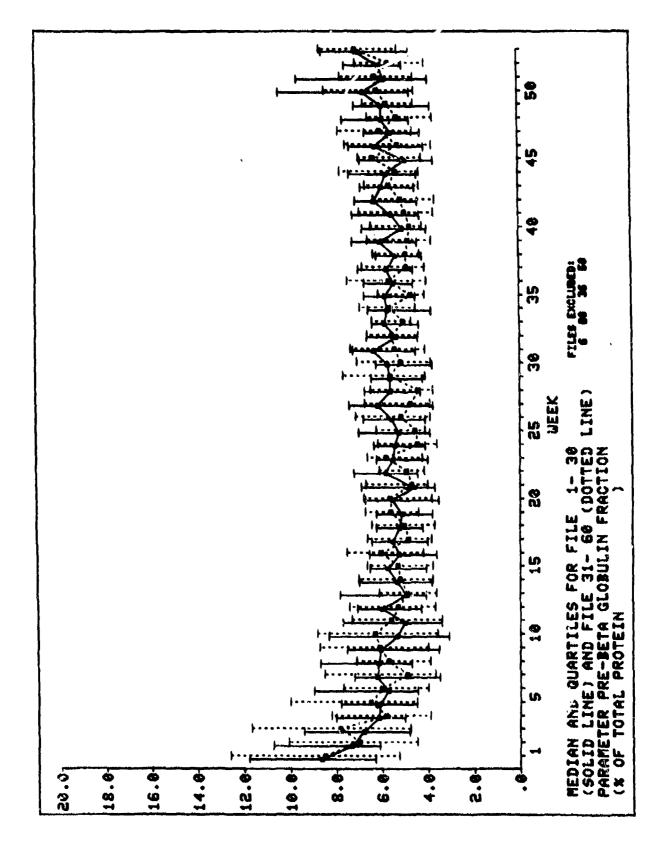


BECOME EXECUTED IN FIRE WITH IN THE PARTY.

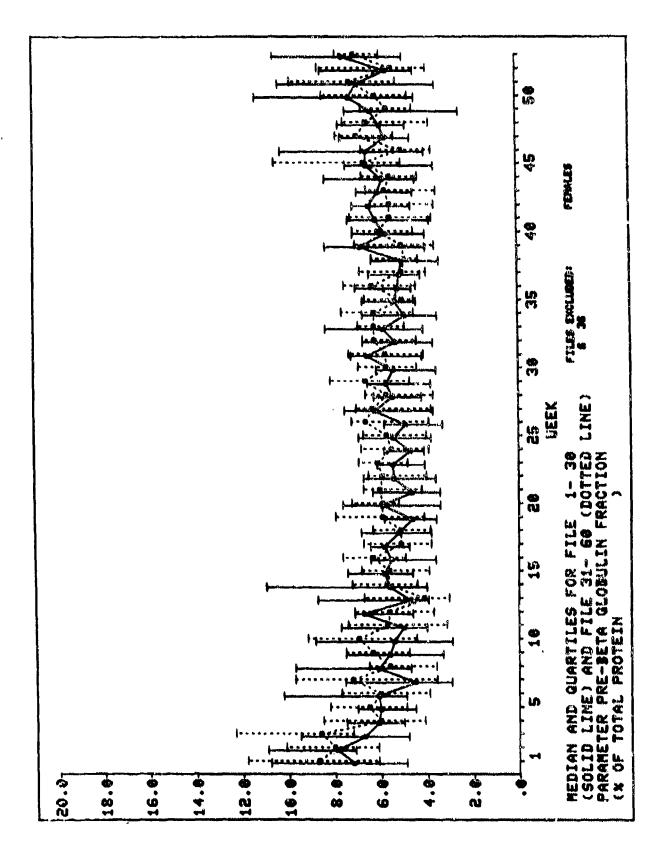


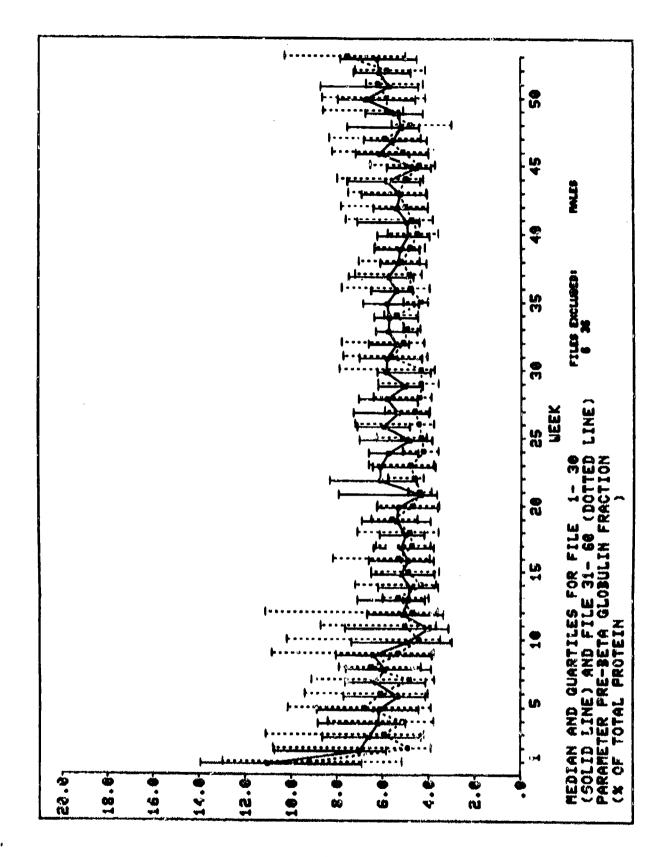


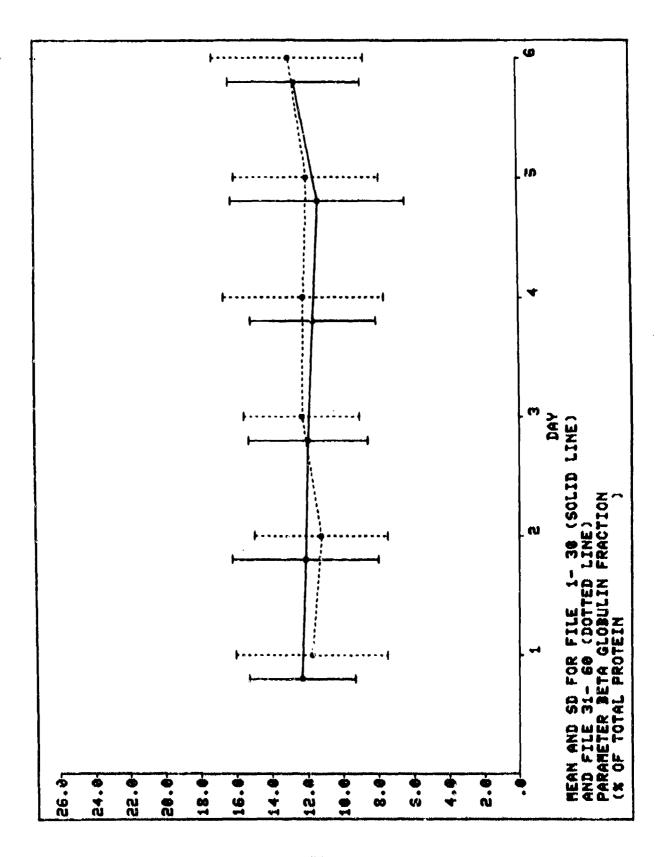


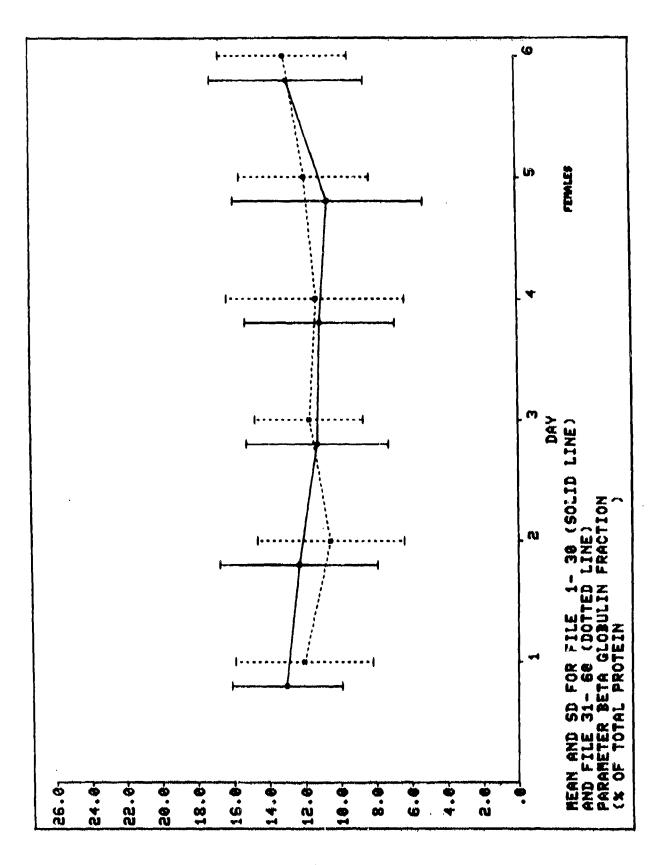


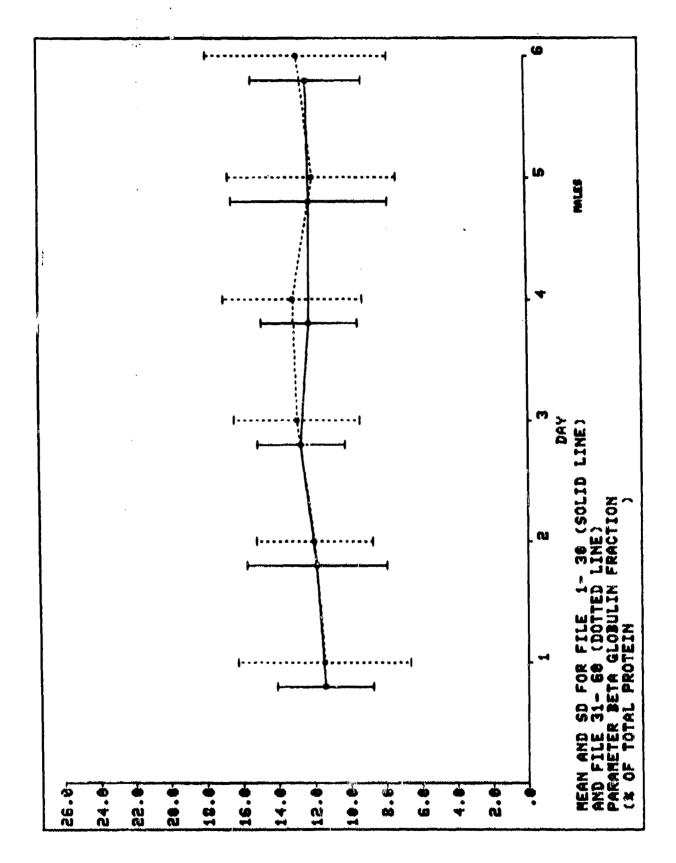
The state of the s

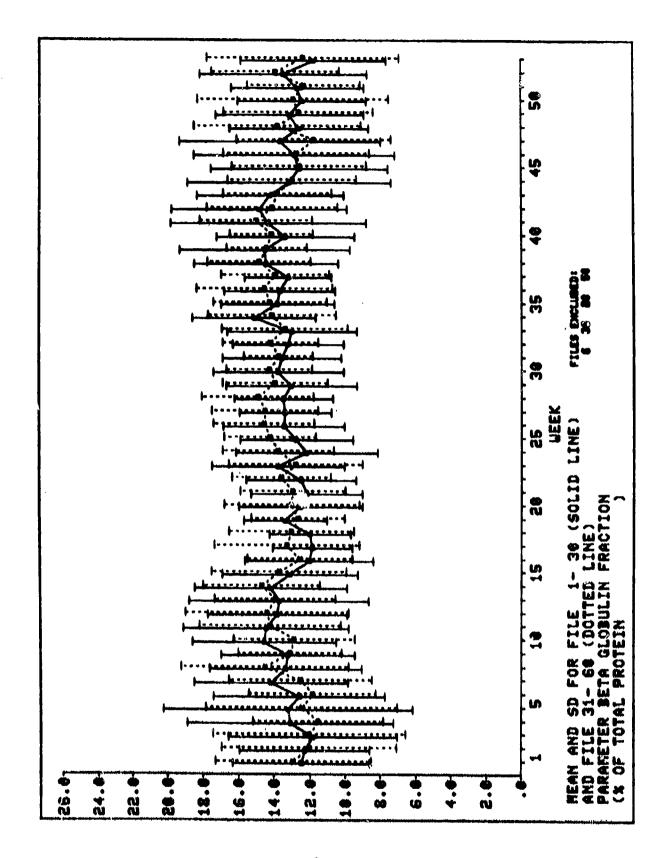


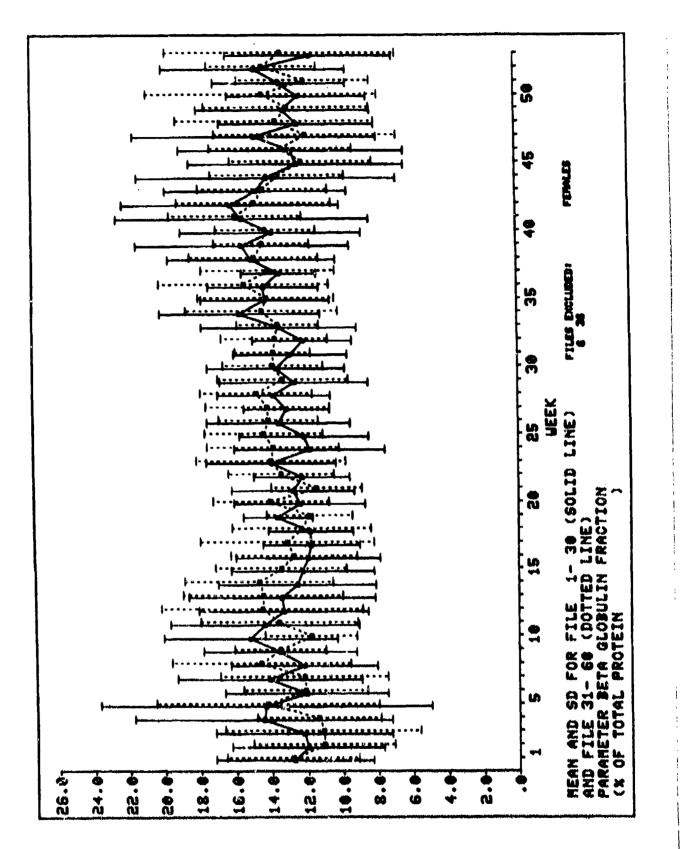


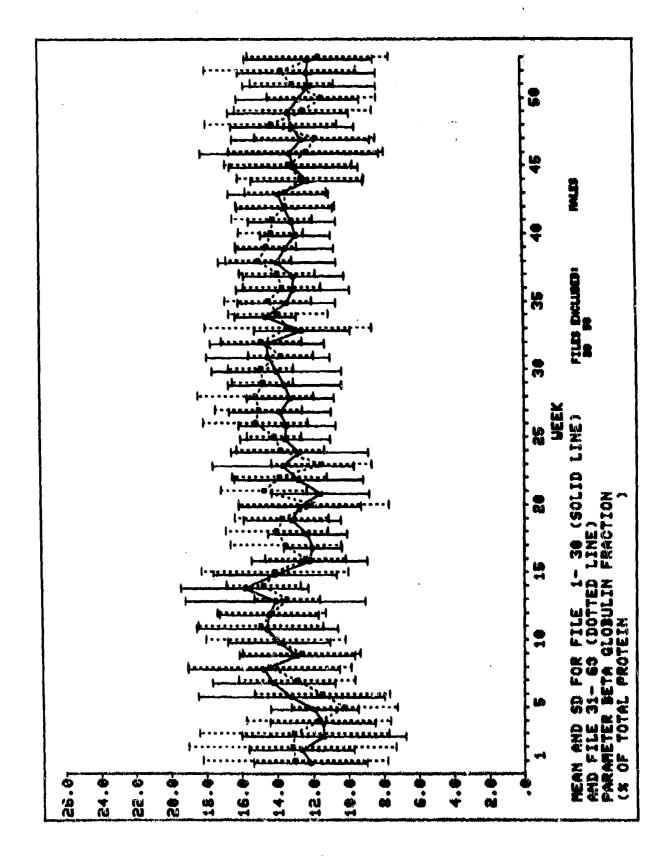


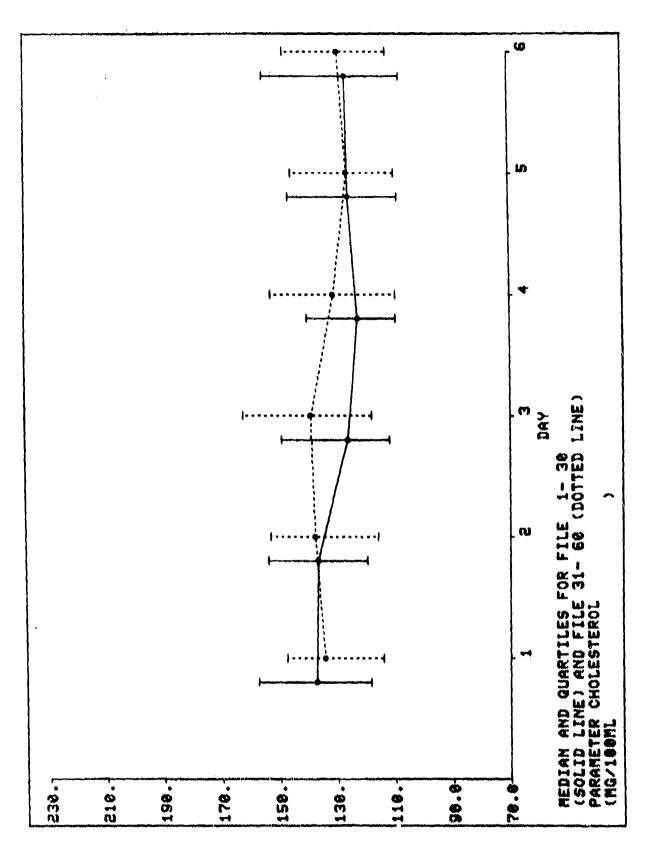


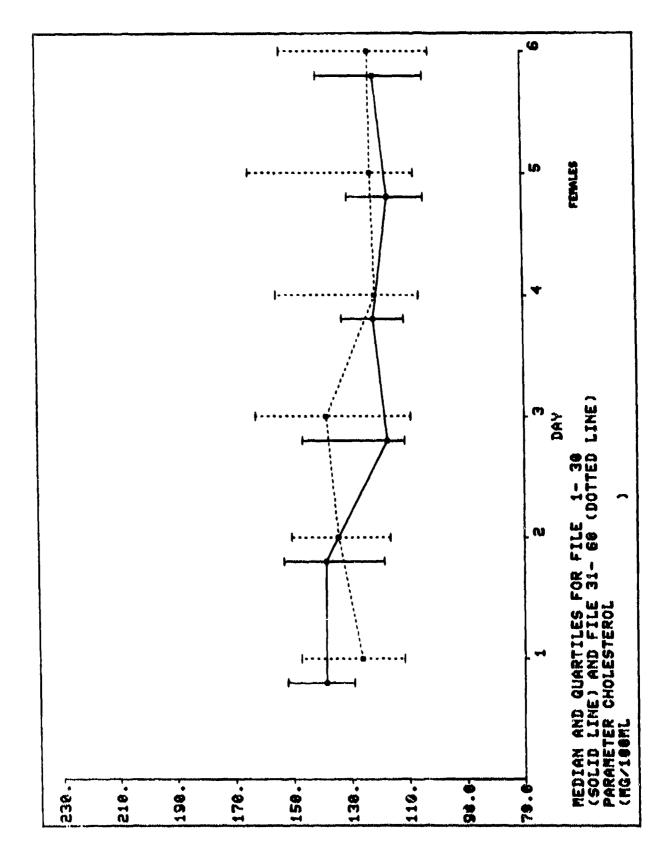


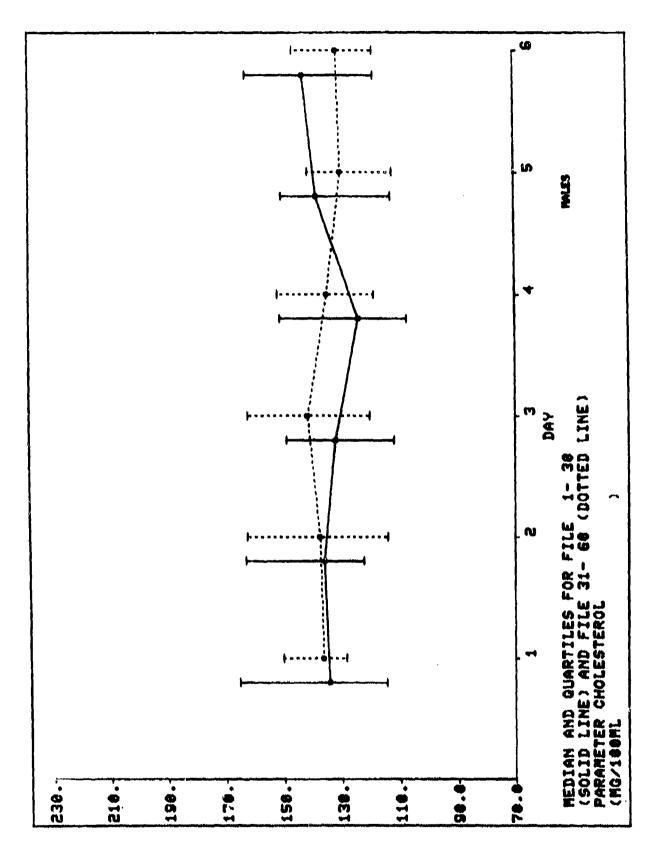


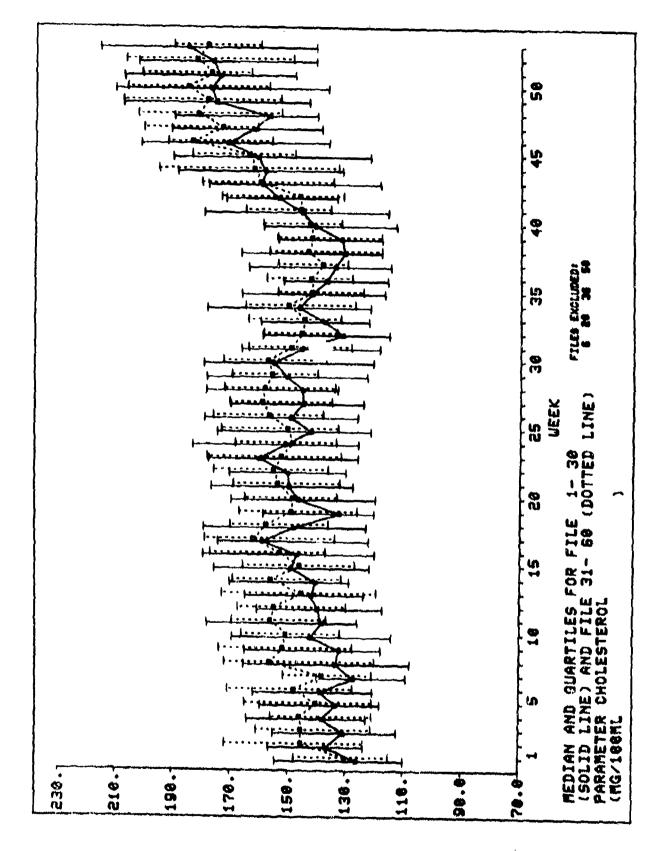


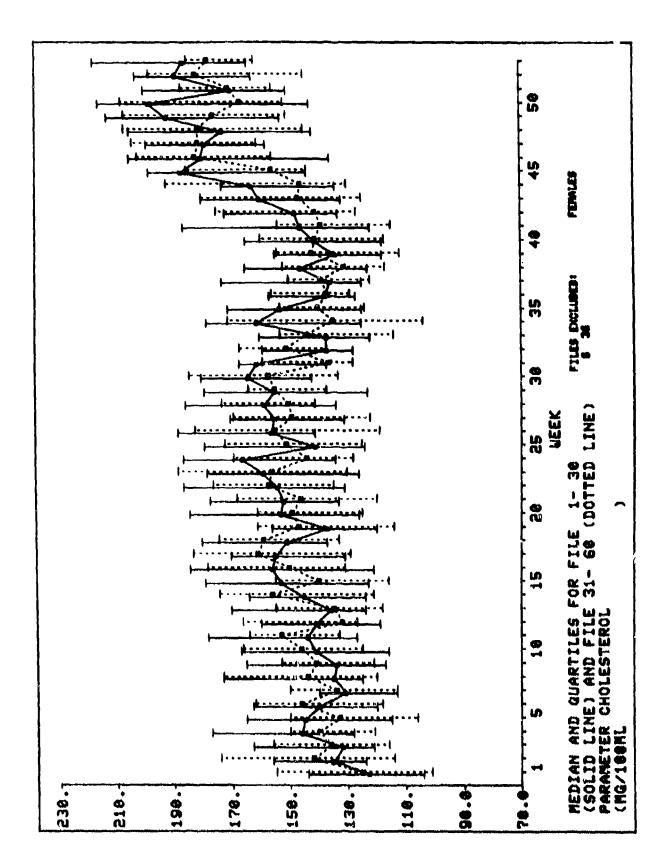




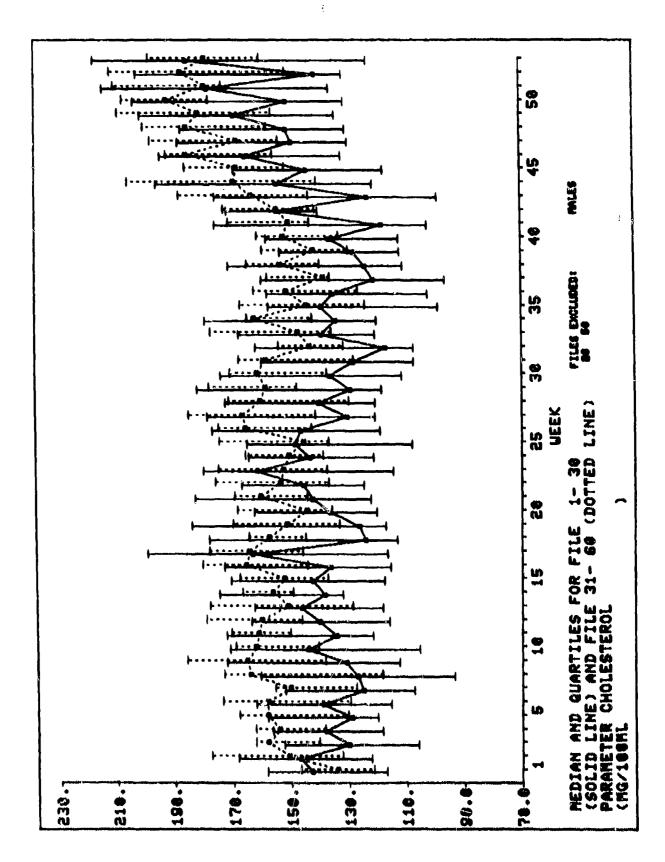


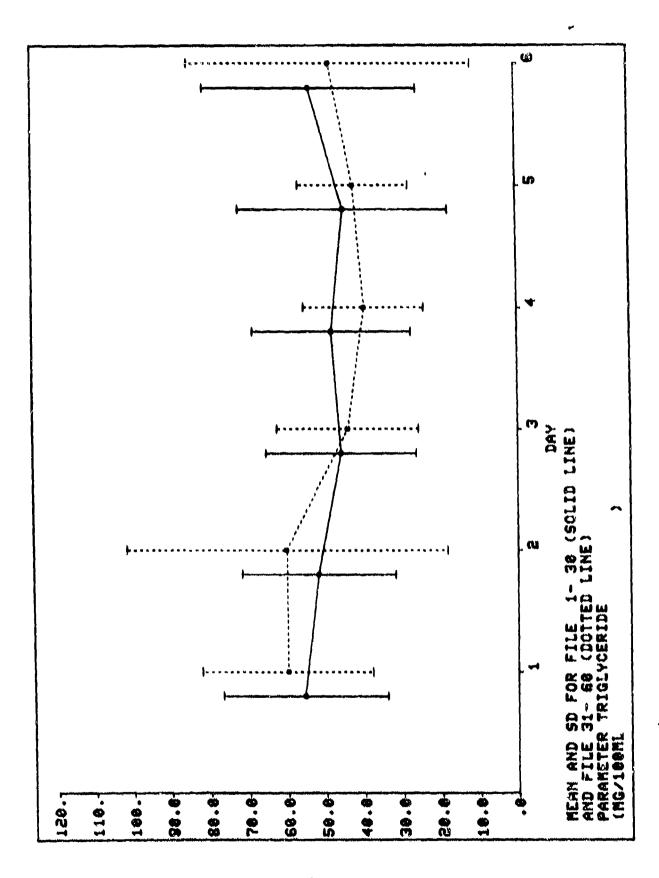


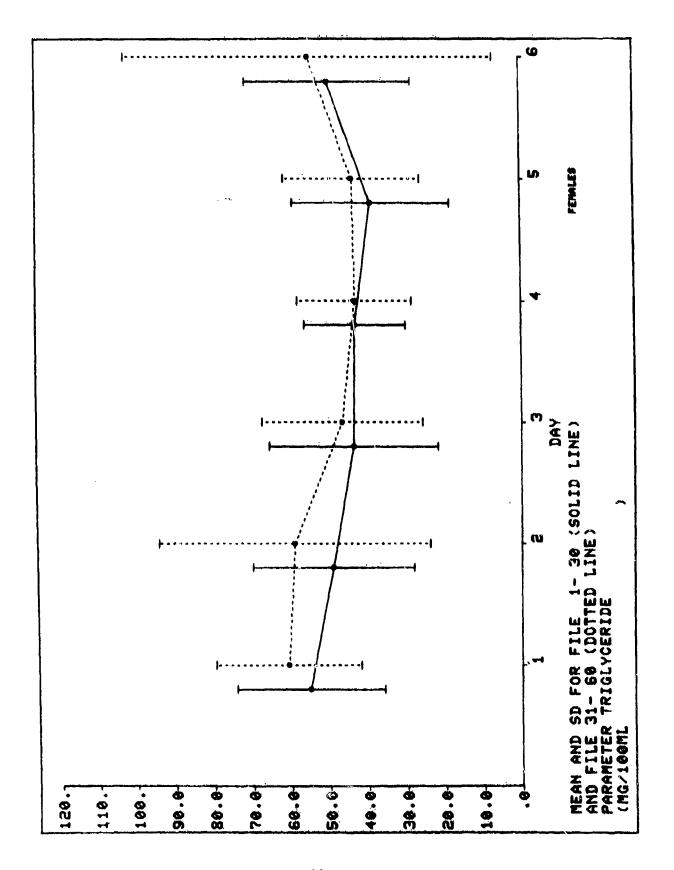


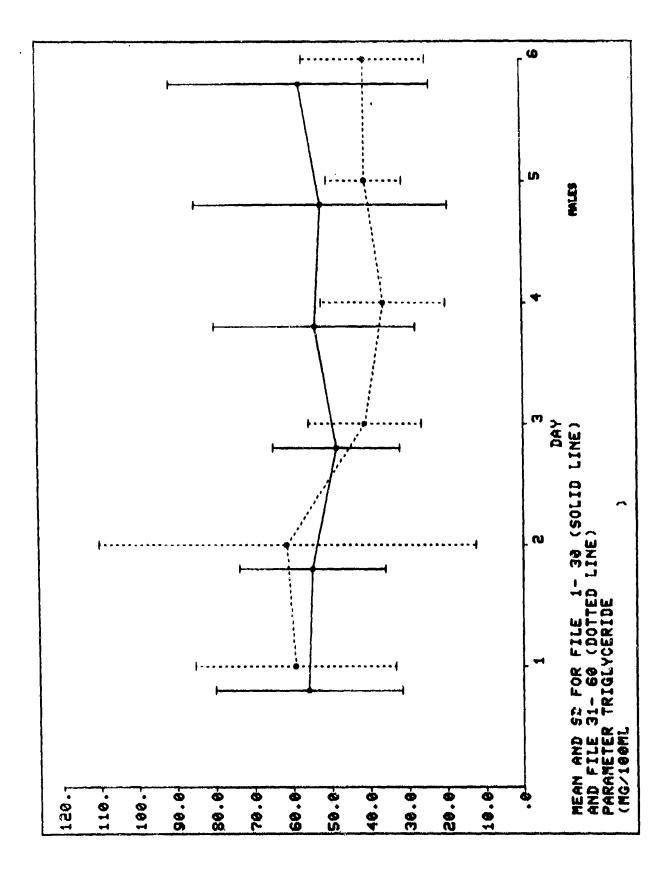


The state of the s

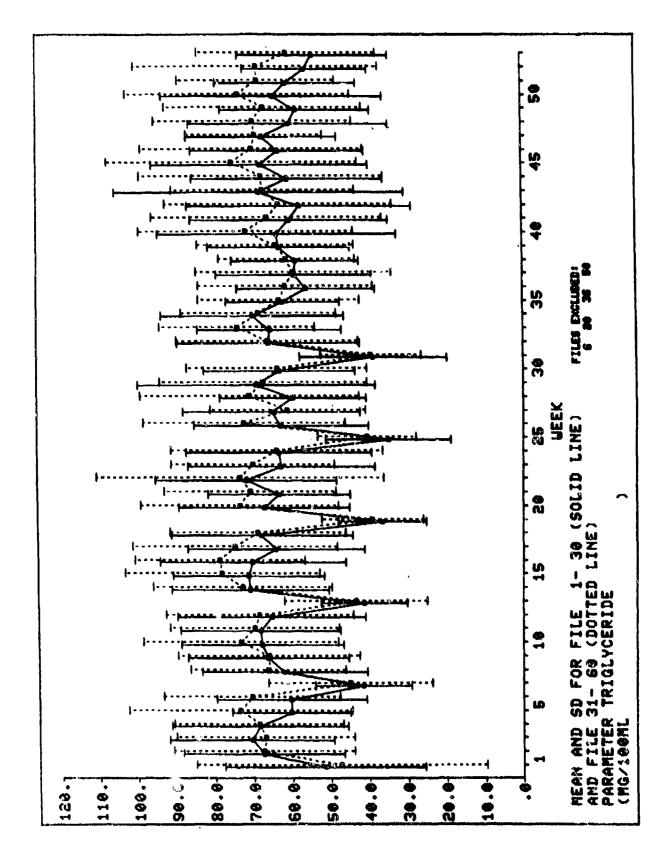




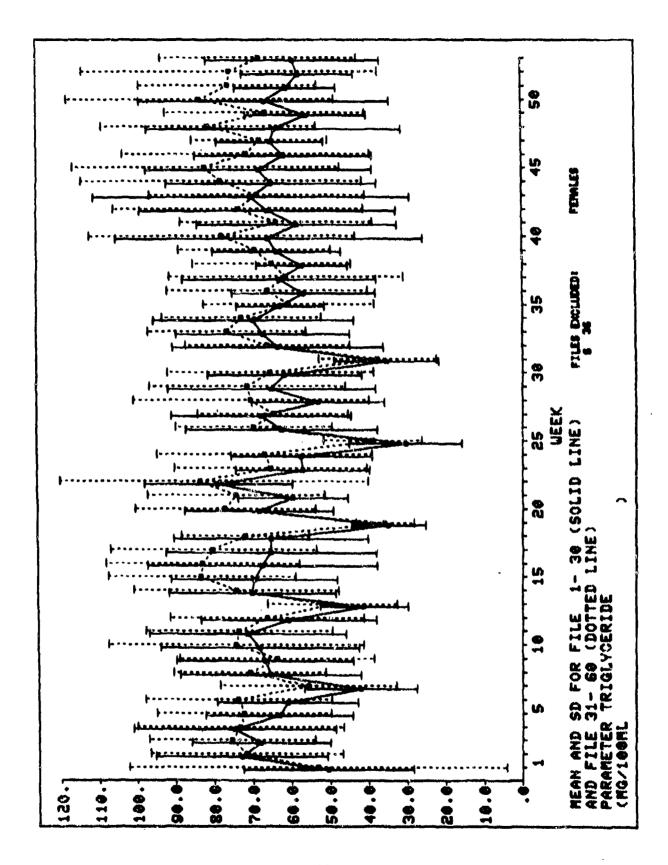




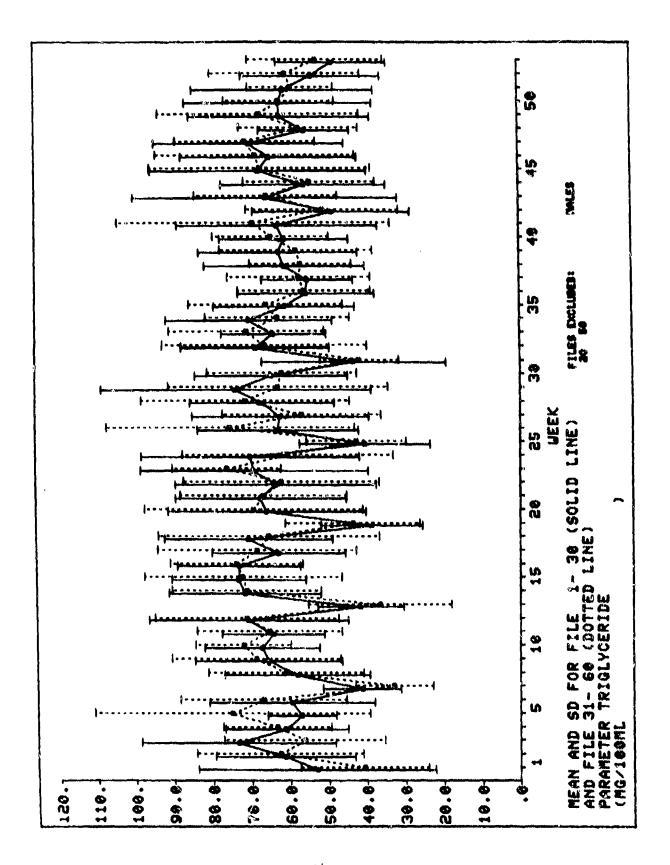
是是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们 第二章 1918年 - 19



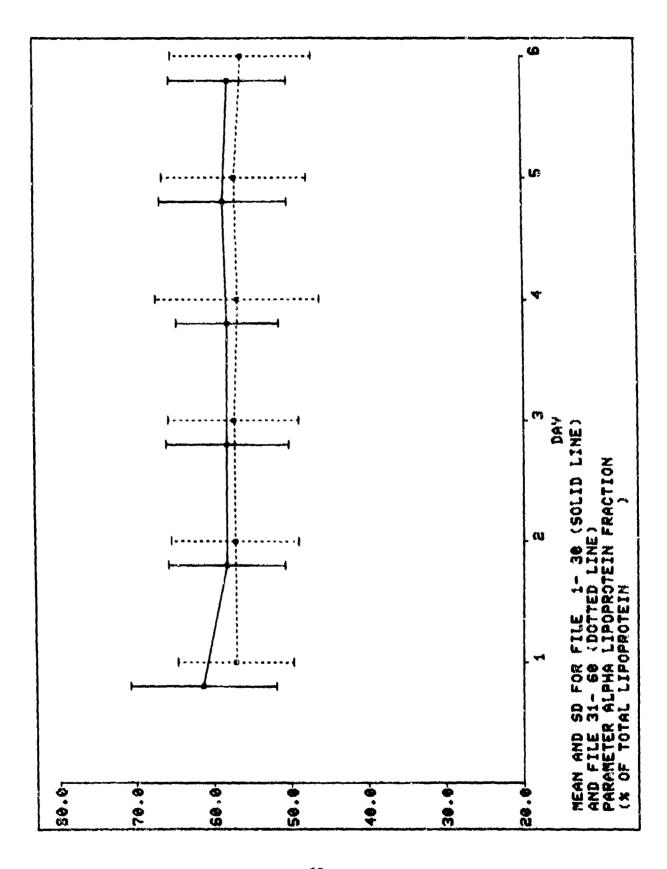
Carrie Contract

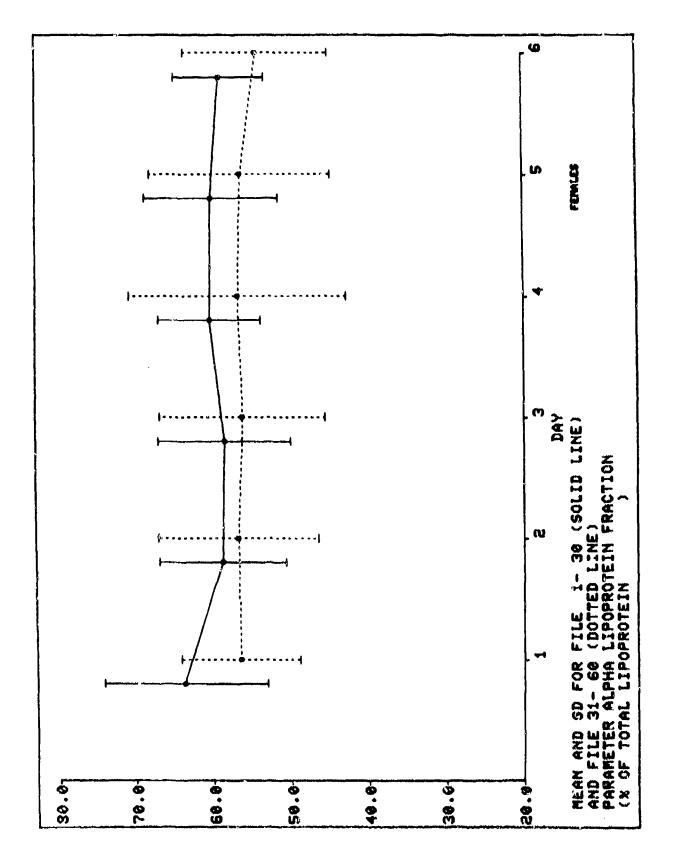


the state of the s

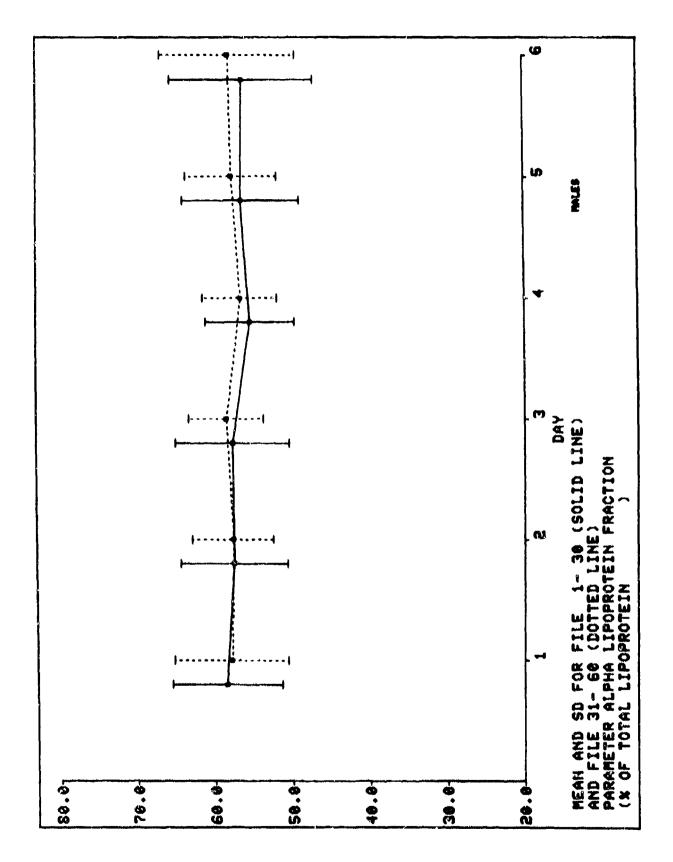


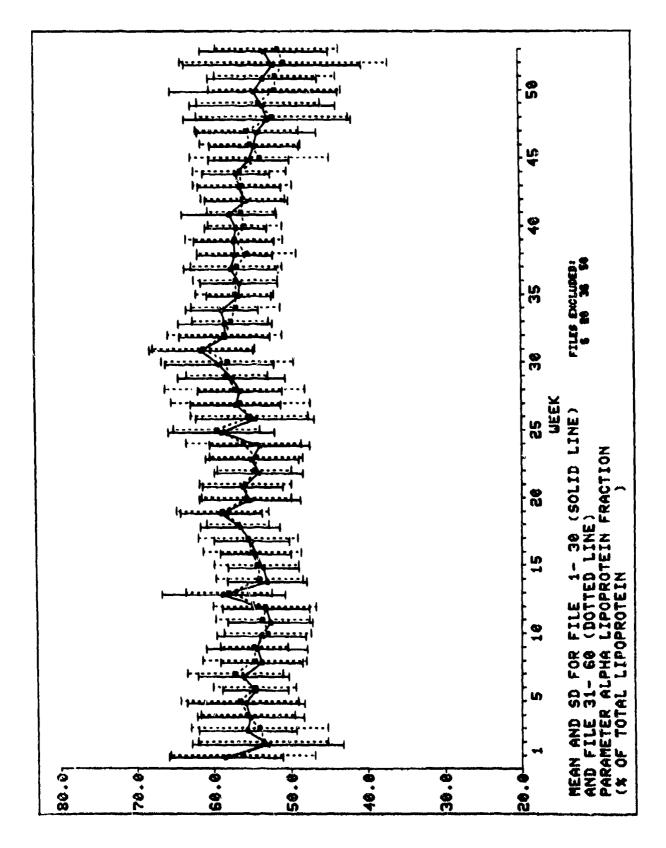
 $S_{k}^{k} = W_{k+1} - V_{k} \tilde{S}_{k} + \lambda \tilde{C}_{k} \tilde{S}_{k} - S_{k} \tilde{S}_{k}^{k}$ 

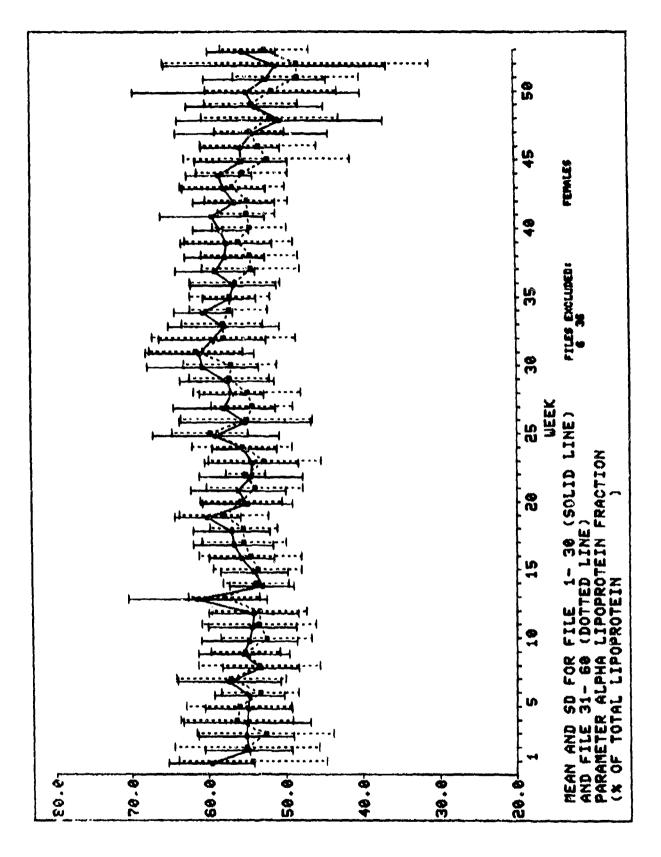


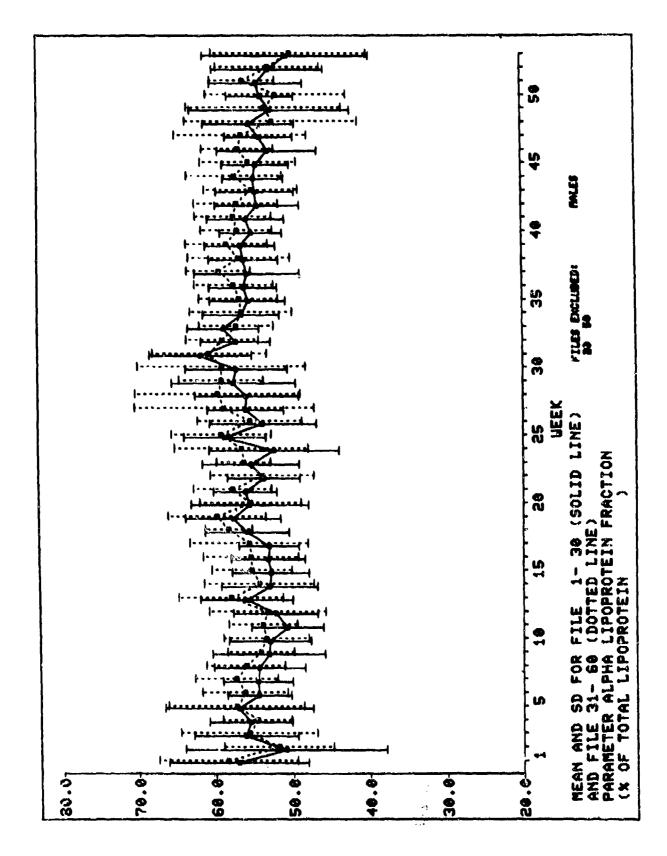


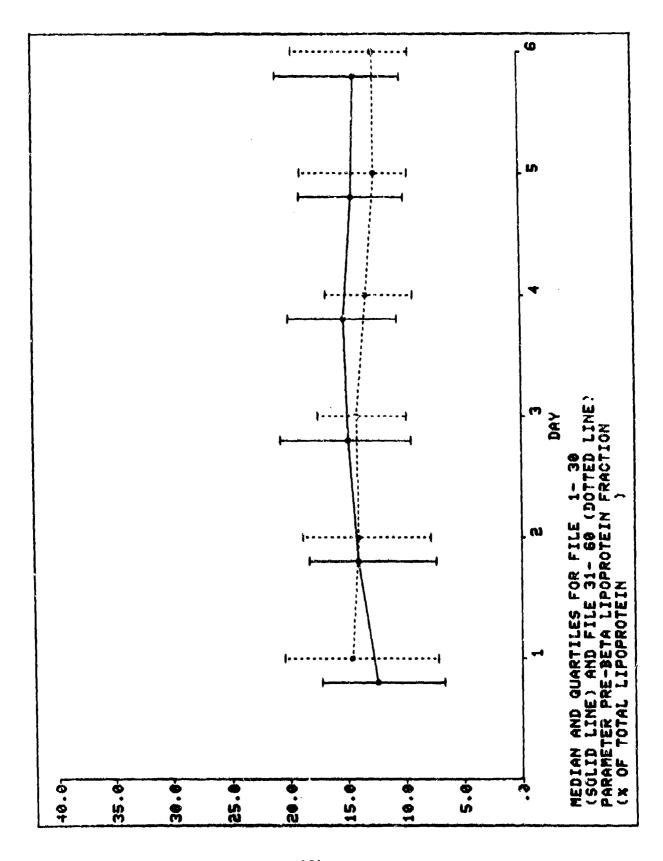
を記録を記述される。

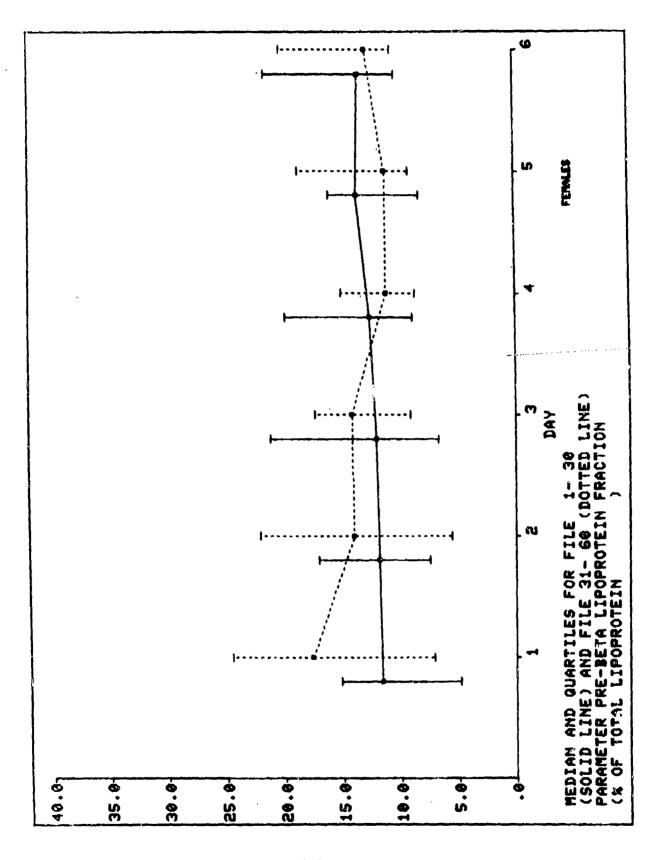


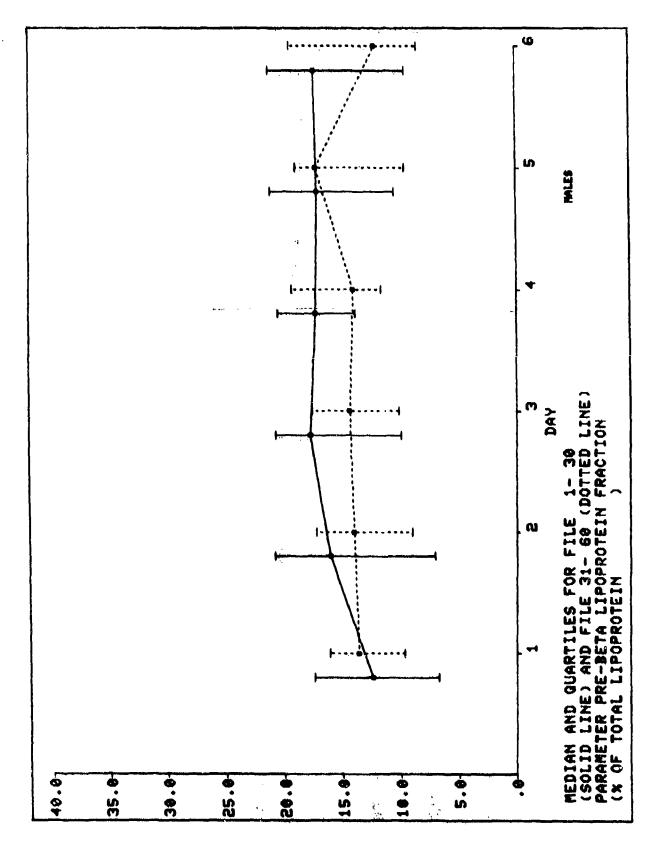


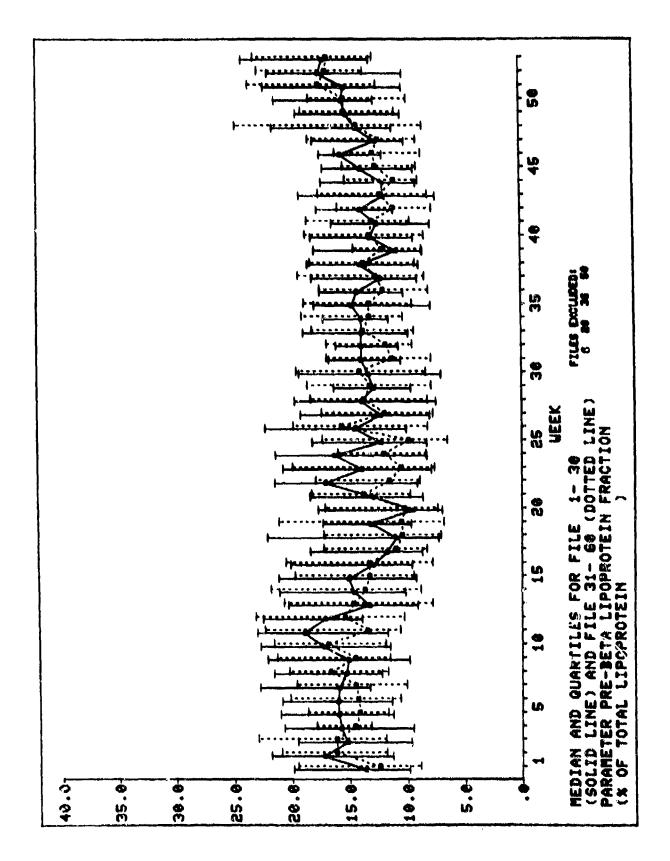


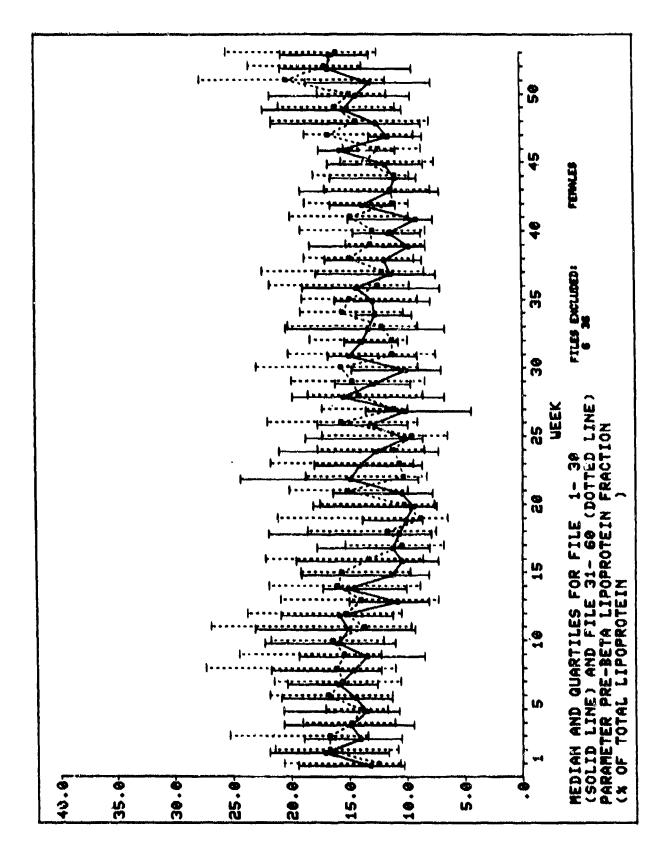


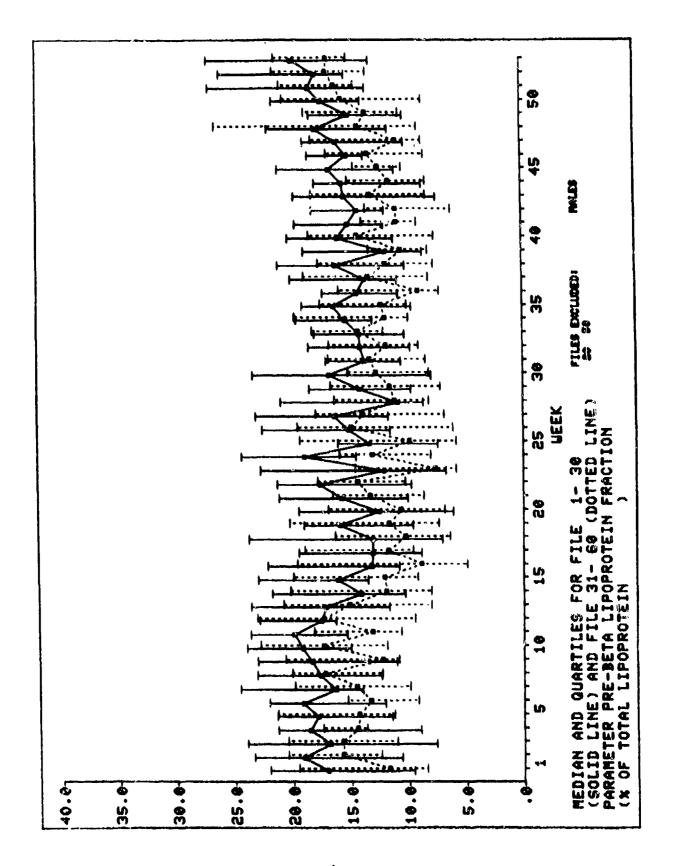


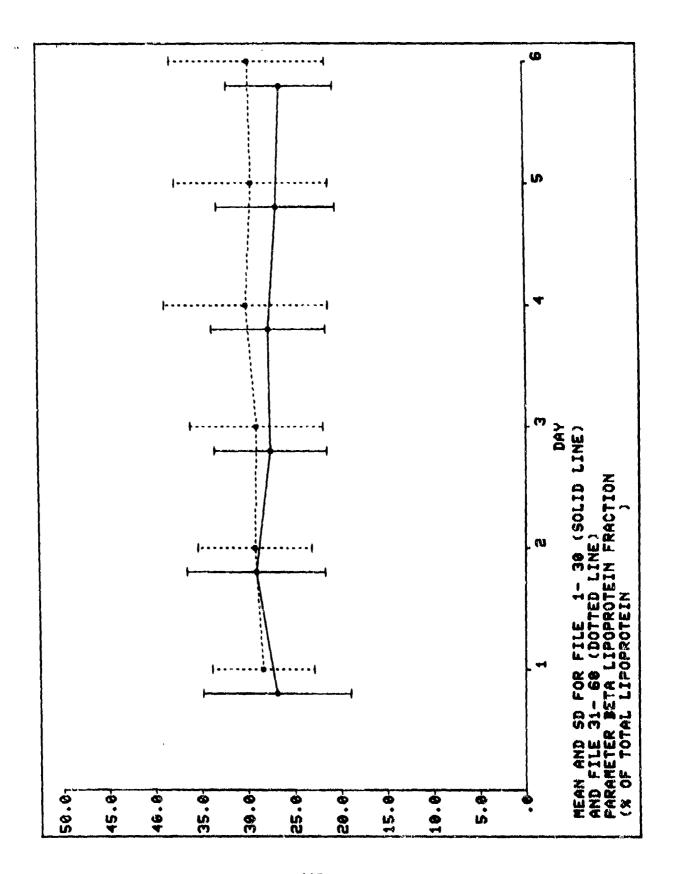


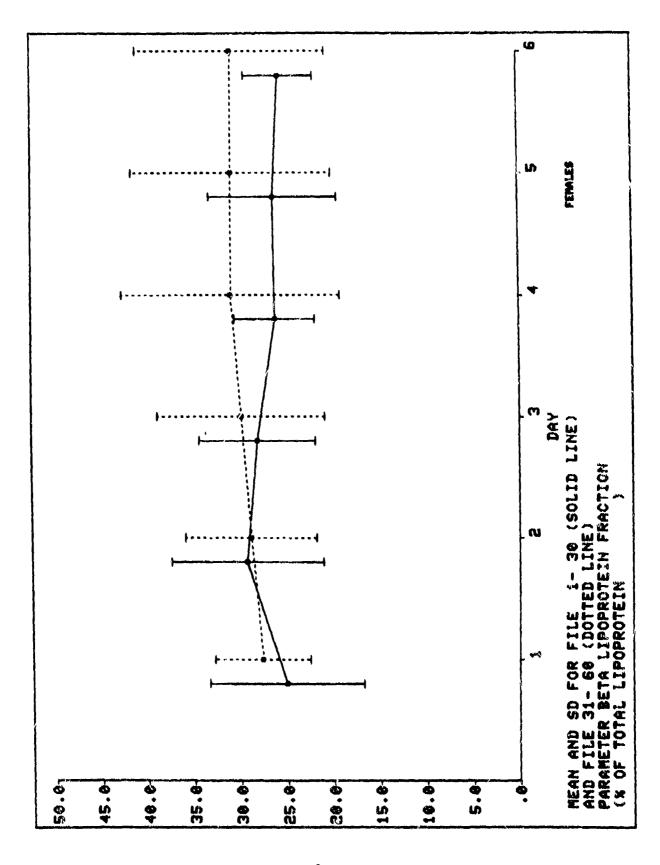


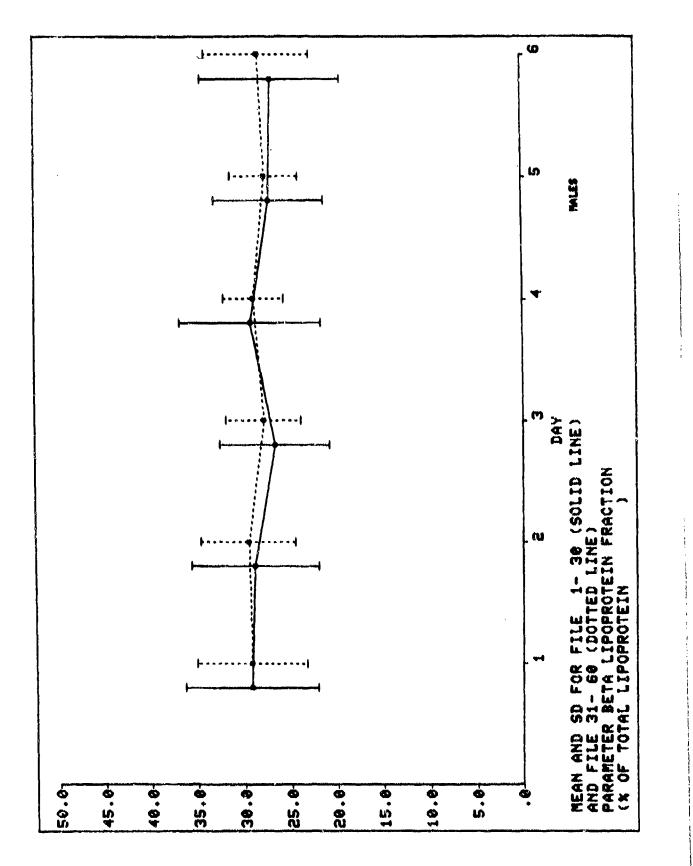


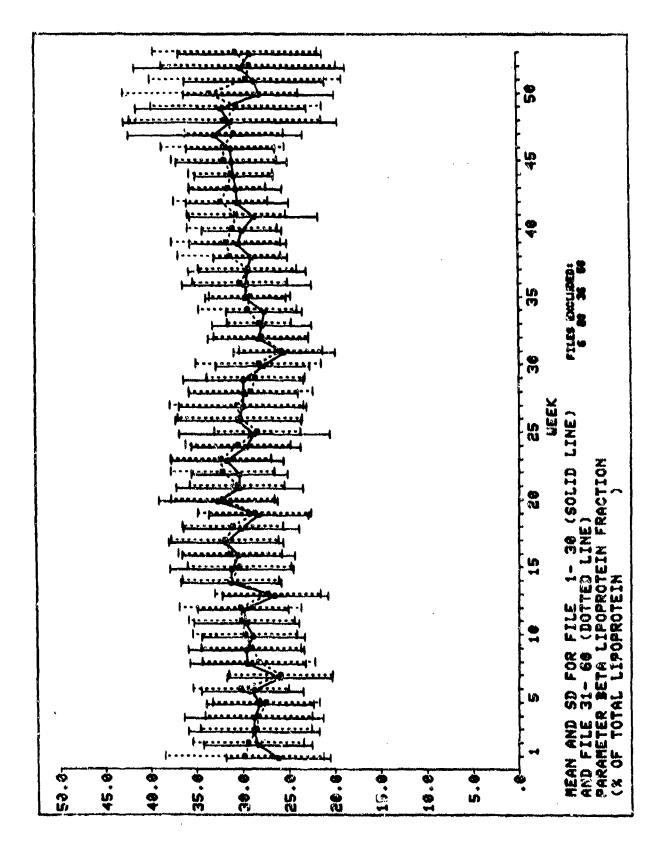




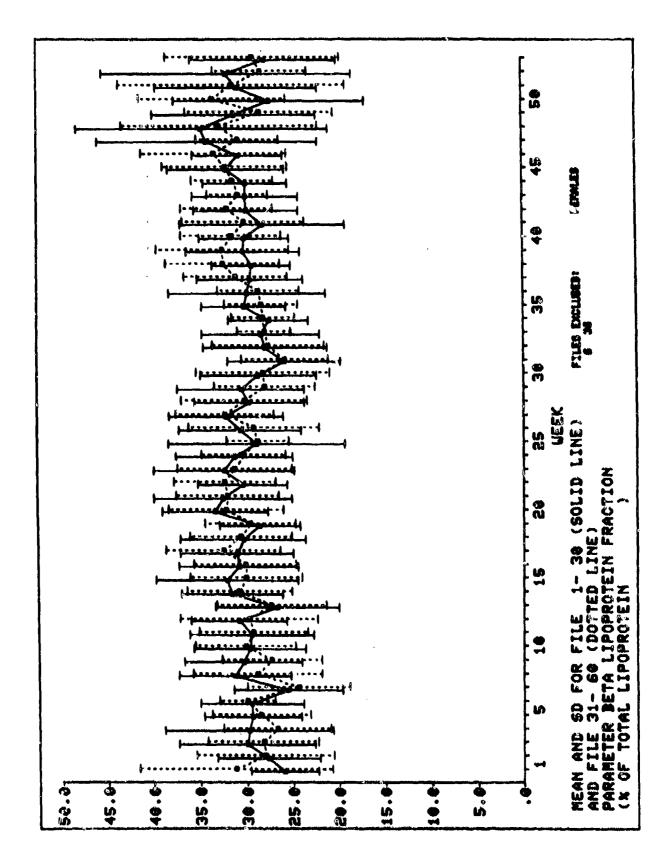


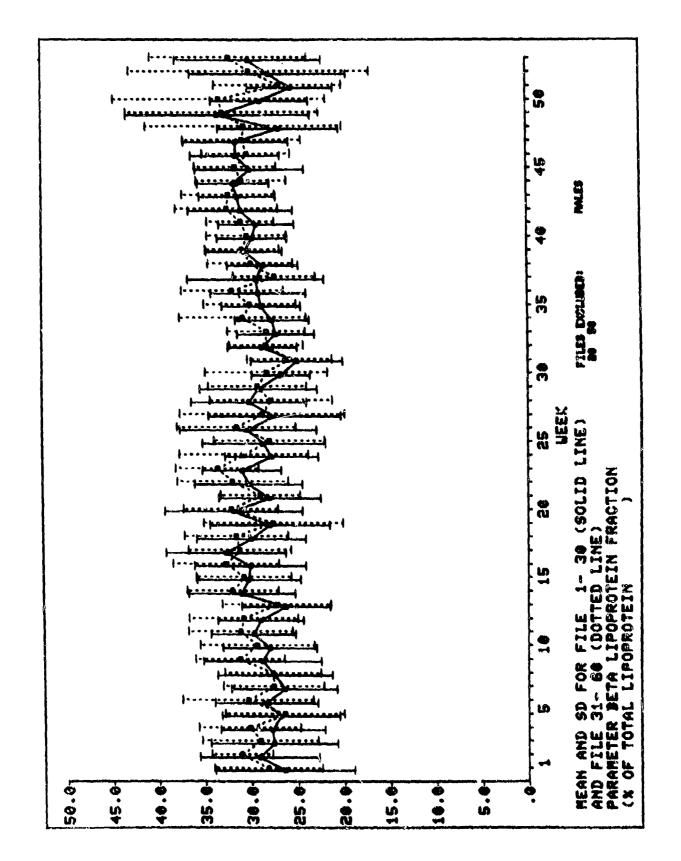




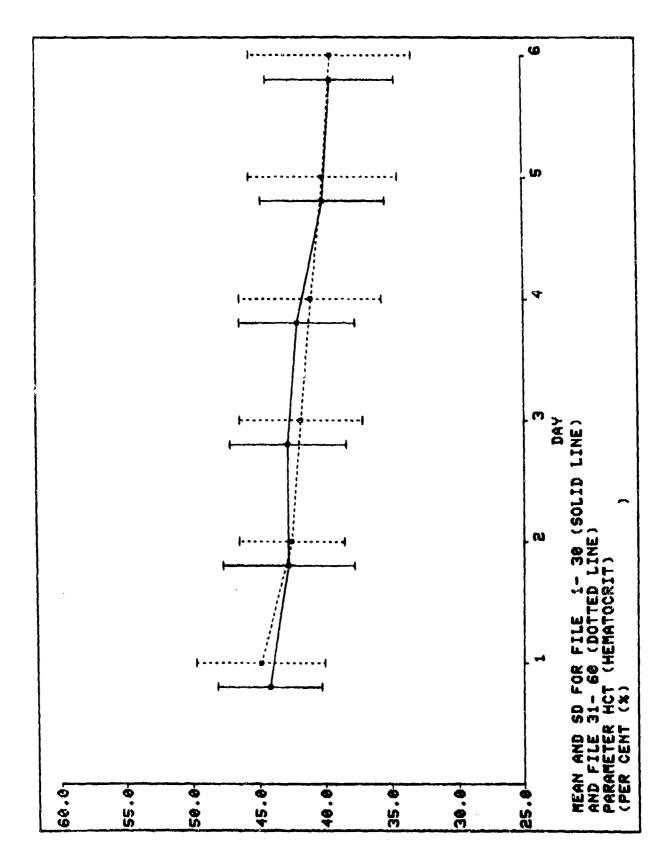


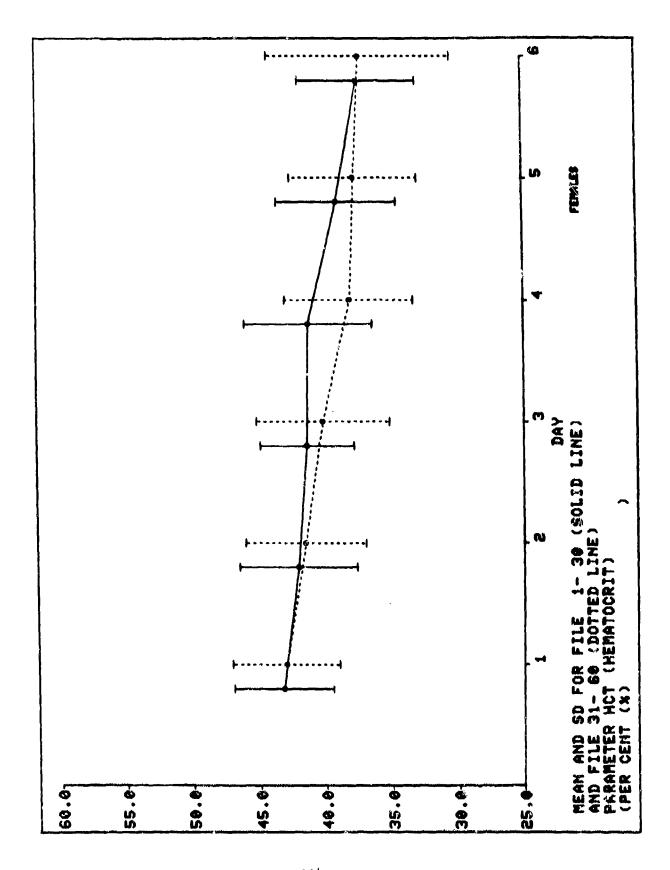
\$11.70. VIX. (1.4.5.)

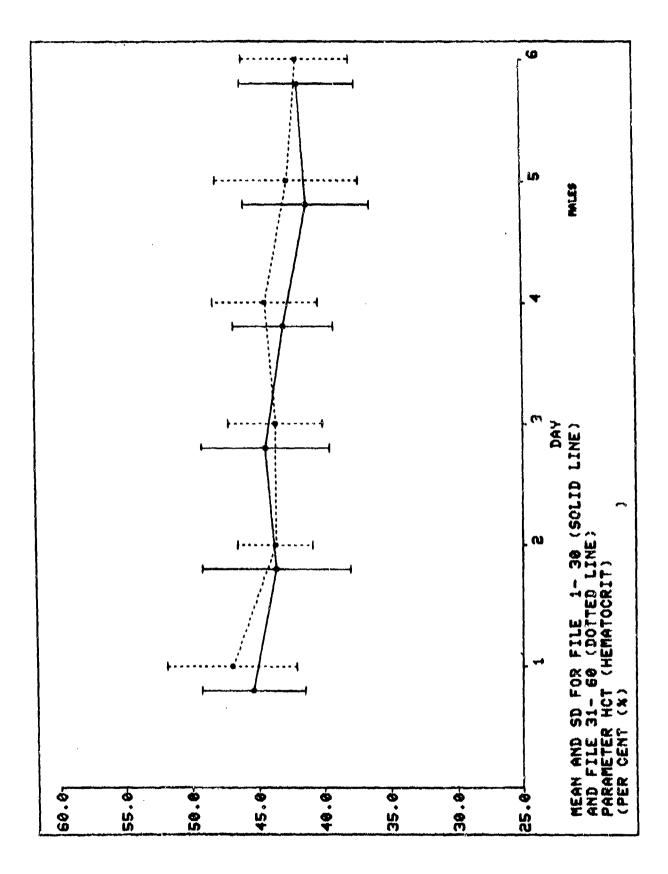


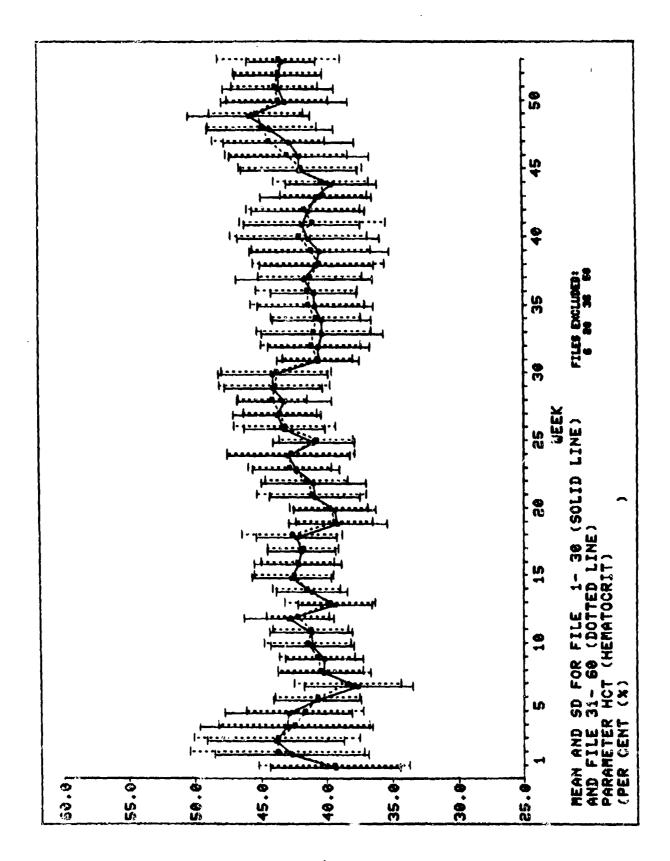


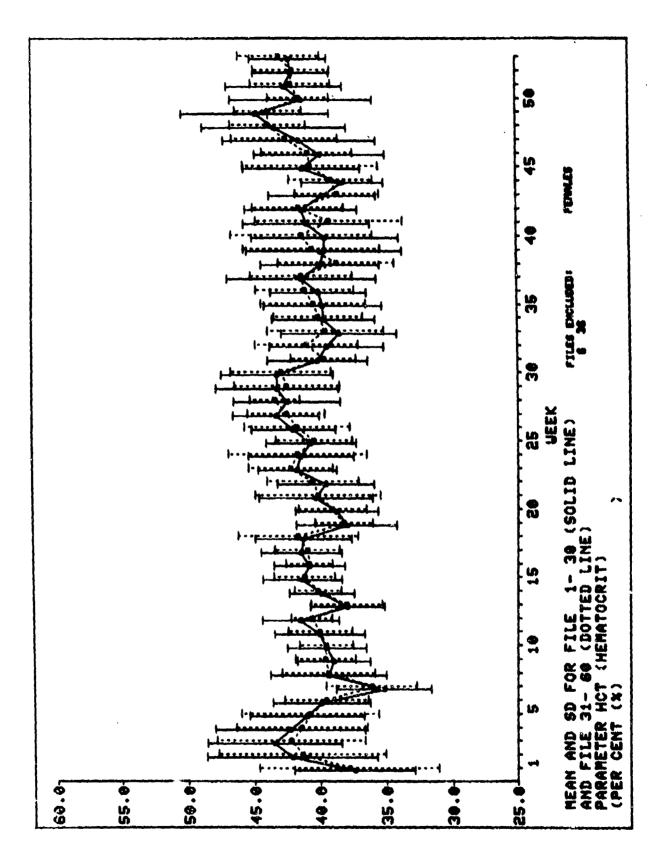
 $\mathbb{Q}_{n}^{k}(x_{k}) = \mathbb{Q}^{k}(x_{k}) \times \mathbb{Q}^{k}$ 

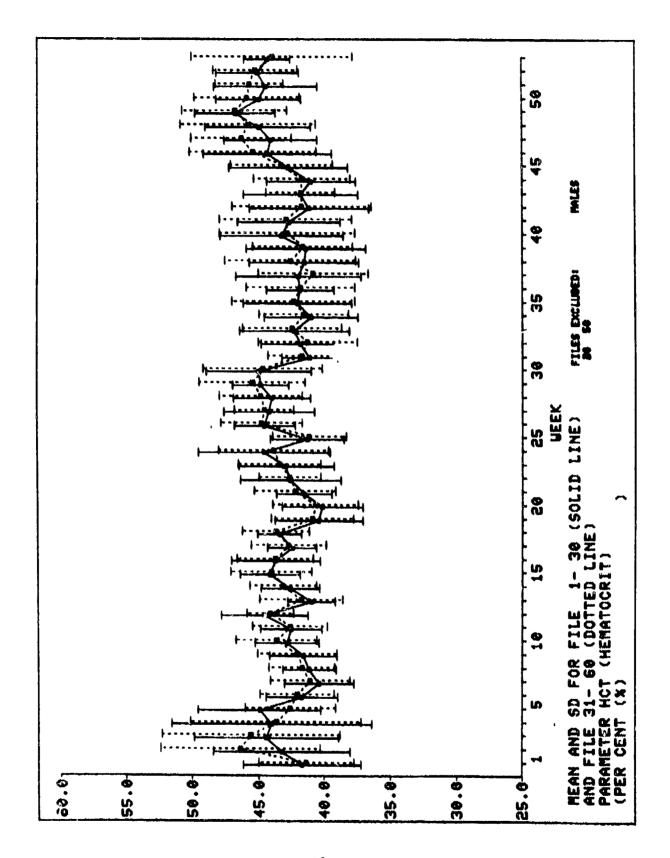






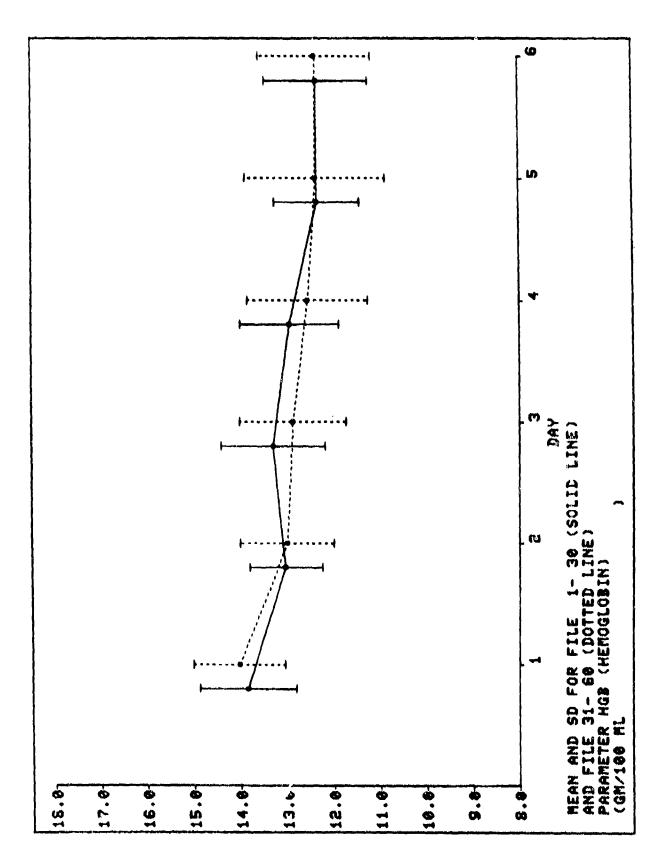


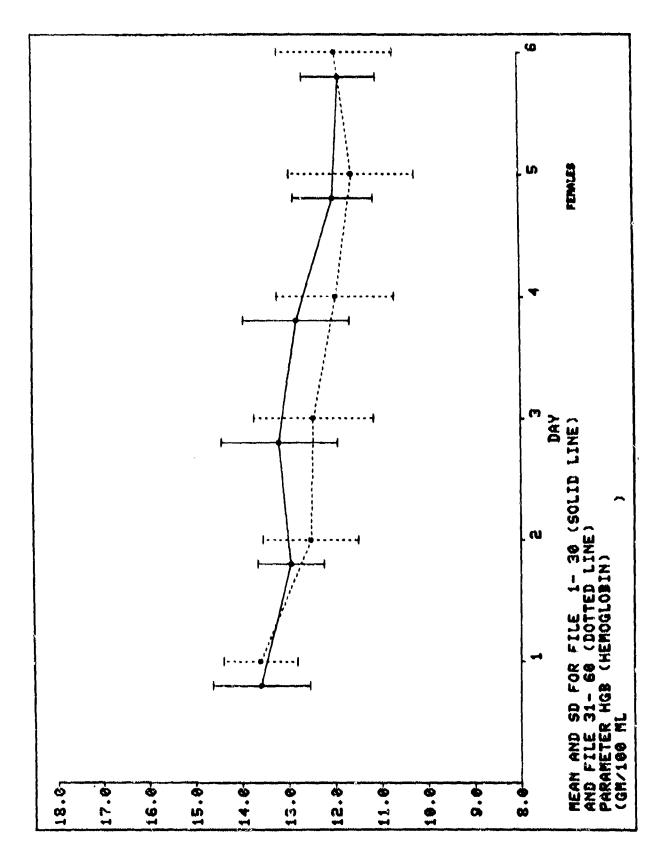


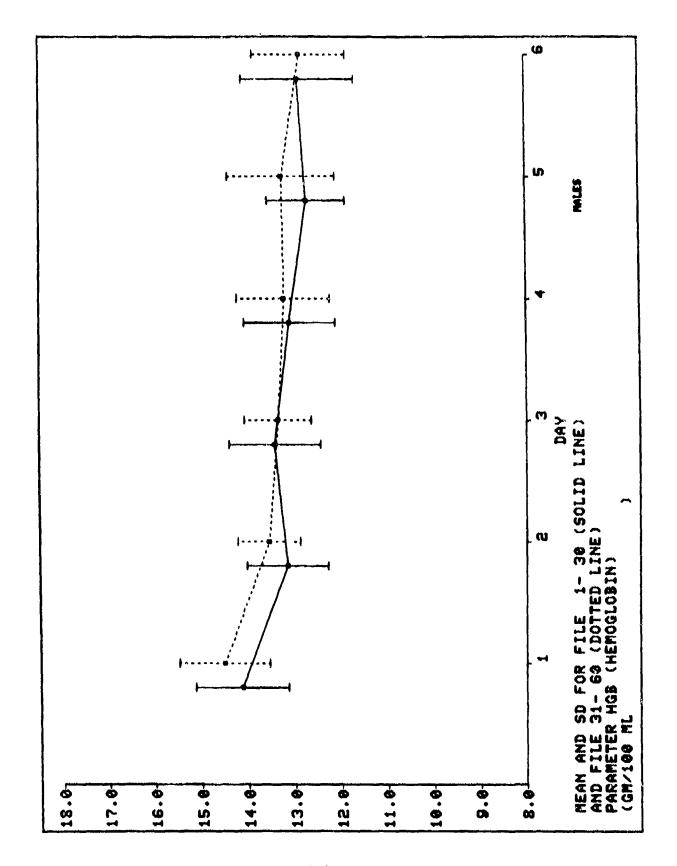


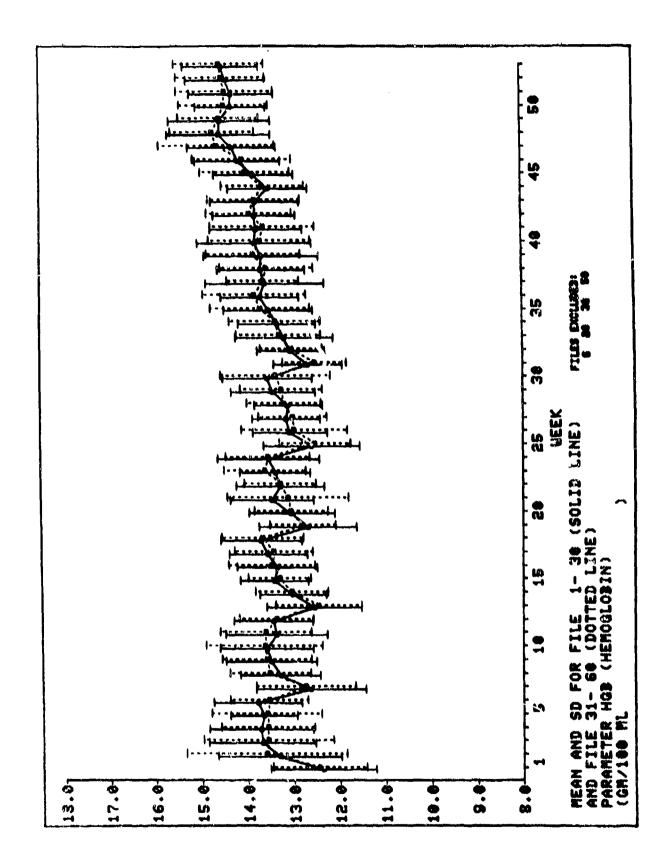
المجافية المحارية والمكام والمداع والمساوية والماء كالماءات فالمساء فللماعية والمقاسدات والماسوناتات واستعماه ما

 $\widehat{\mathcal{A}}_{\mathcal{A}}(\mathcal{A}_{\mathcal{A}}(\mathcal{A}_{\mathcal{A}}(\mathcal{A}_{\mathcal{A}}(\mathcal{A}),\mathcal{A}_{\mathcal{A}}(\mathcal{A}),\mathcal{A}_{\mathcal{A}}(\mathcal{A}))) = 2|\mathcal{A}_{\mathcal{A}}(\mathcal{A}_{\mathcal{A}}(\mathcal{A}),\mathcal{A}_{\mathcal{A}}(\mathcal{A}),\mathcal{A}_{\mathcal{A}}(\mathcal{A}))|$ 



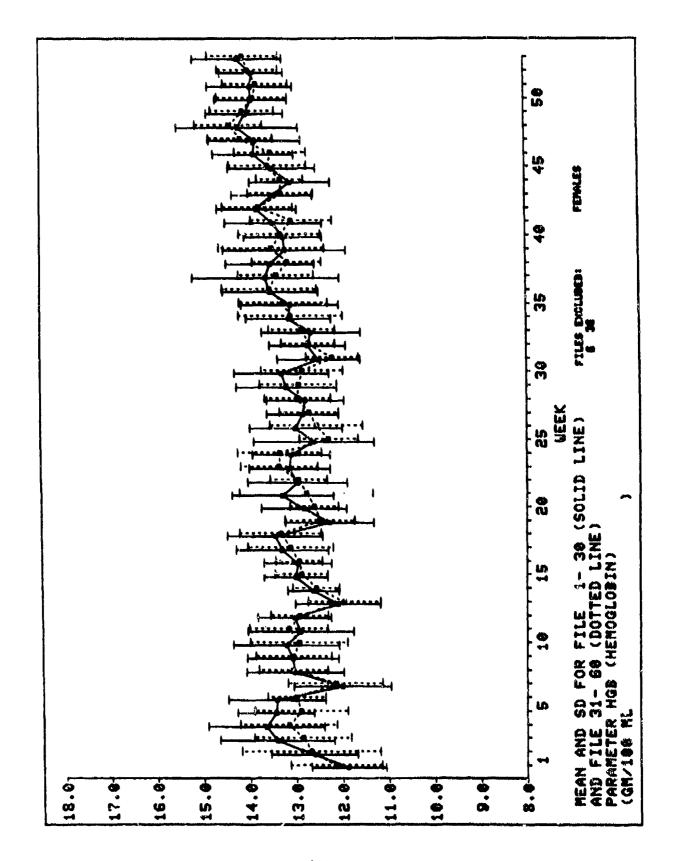


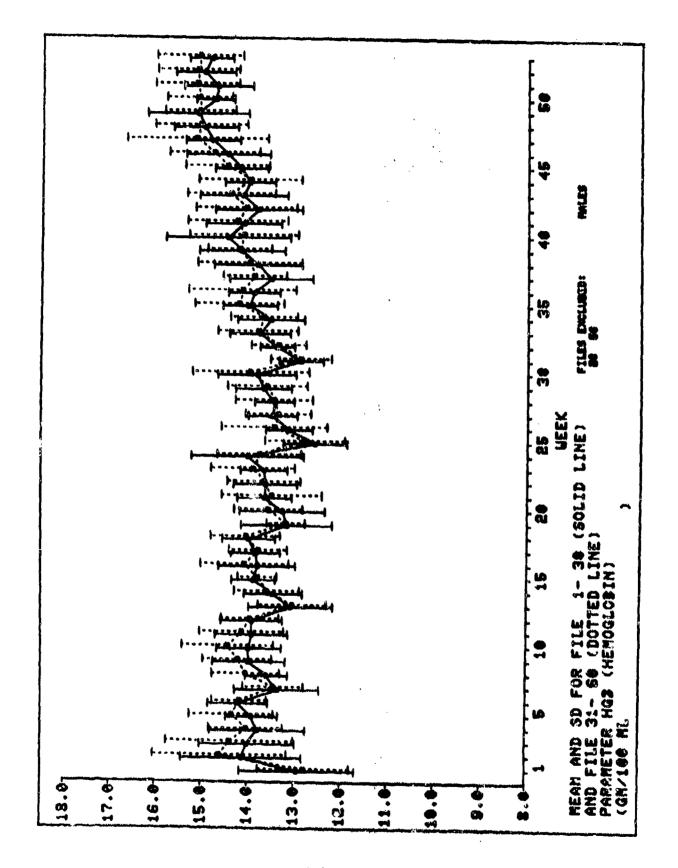


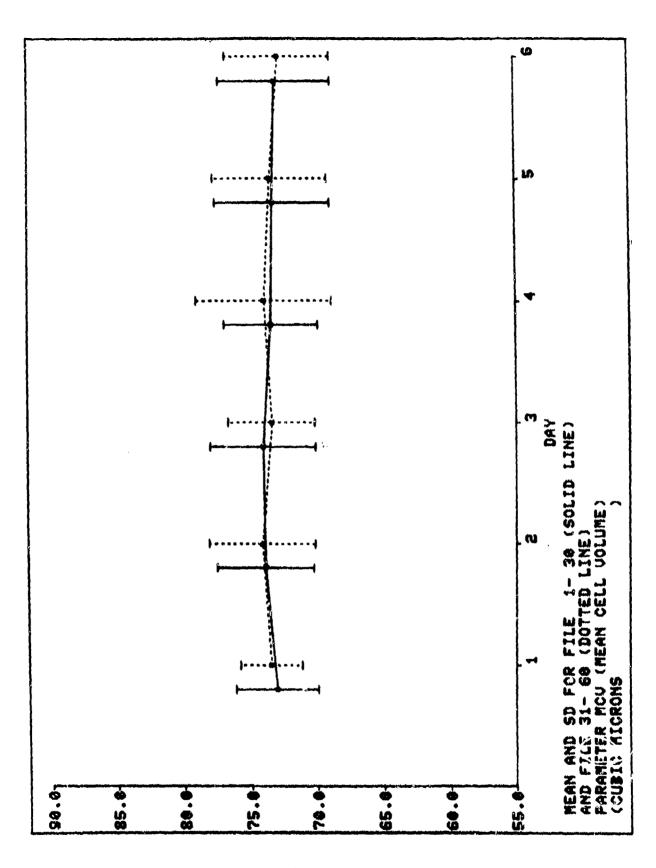


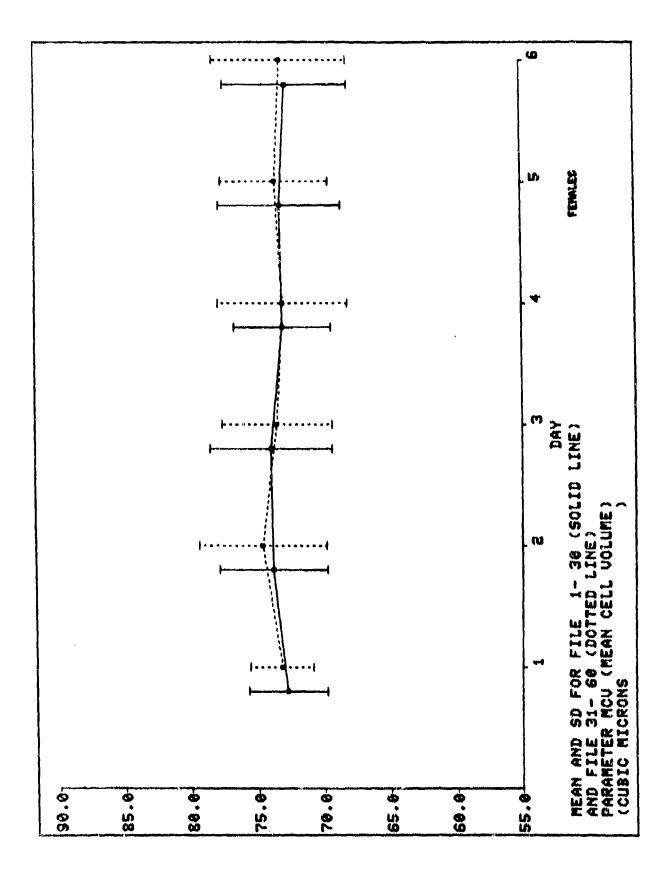
gar plant and an all the last the last the last control of the control of the last t

 $\mathcal{L}_{\mathcal{A}}(\mathcal{F}_{\mathcal{A}}^{(s)}) = \mathcal{L}_{\mathcal{A}}(s) \qquad \text{where } s$ 

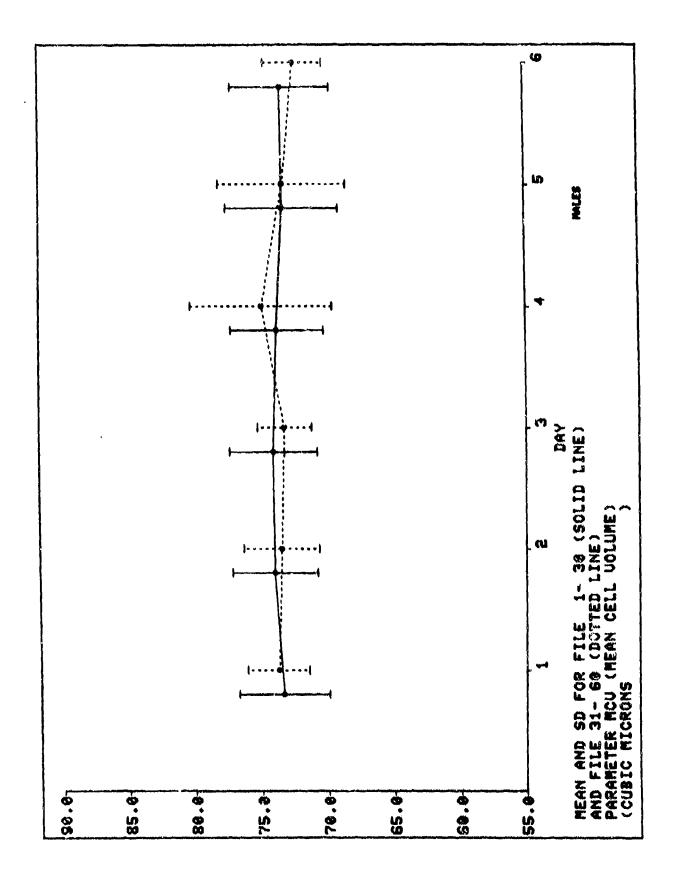


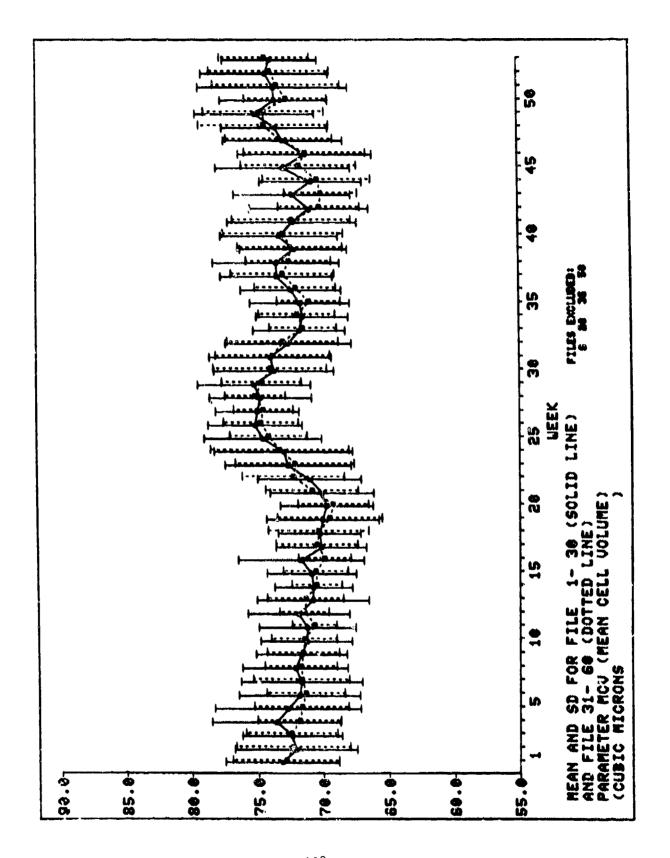


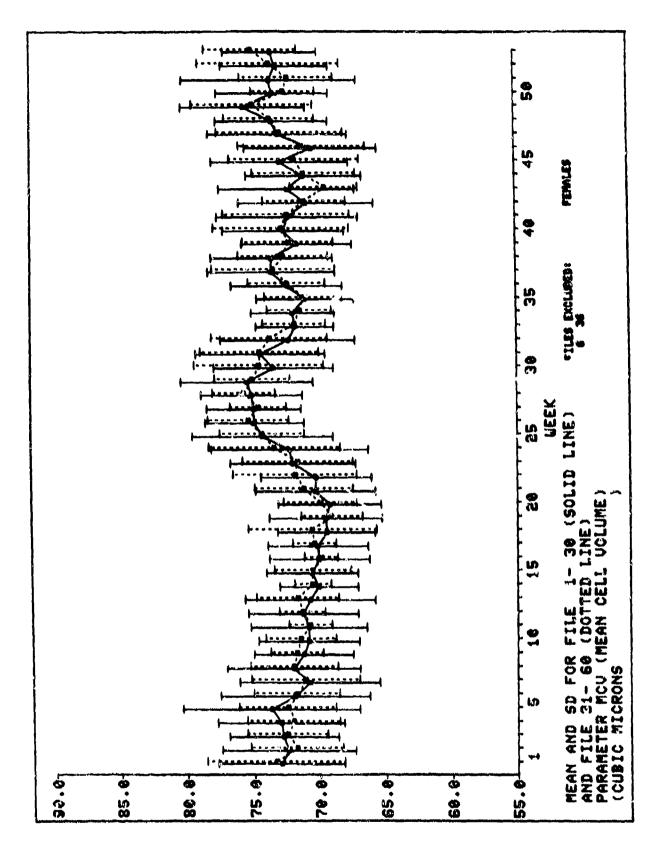


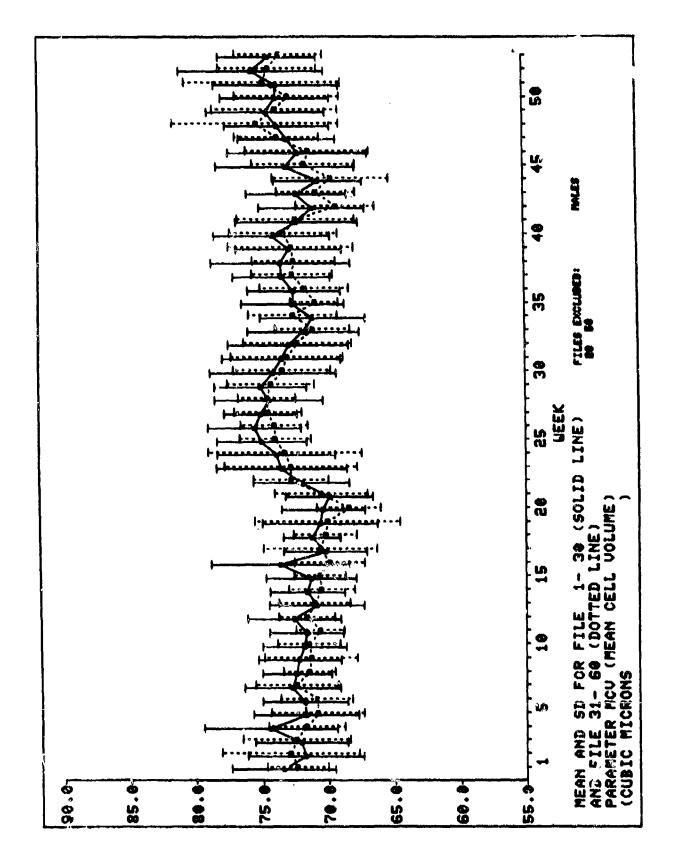


Reserved to the second

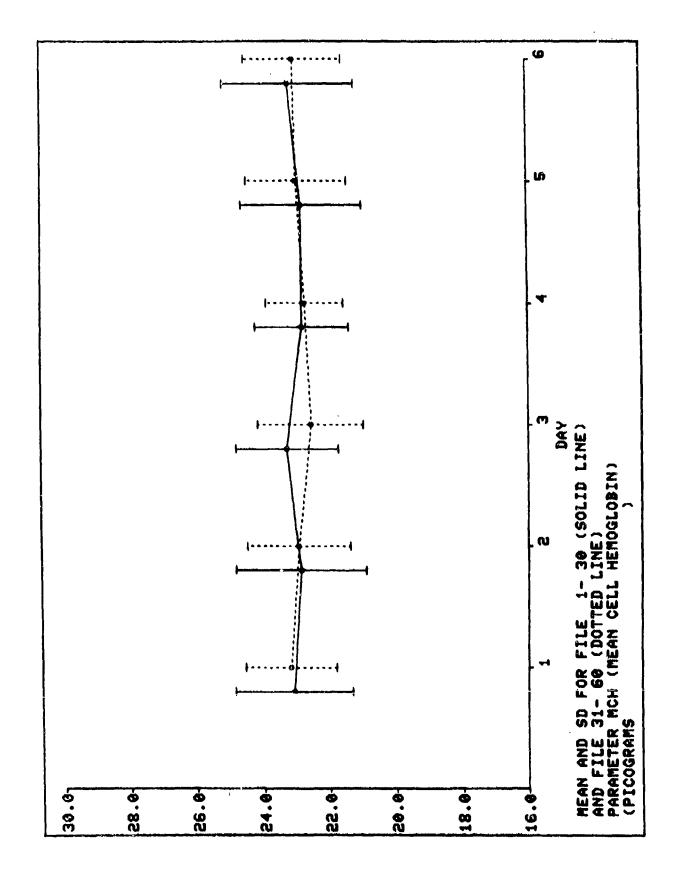


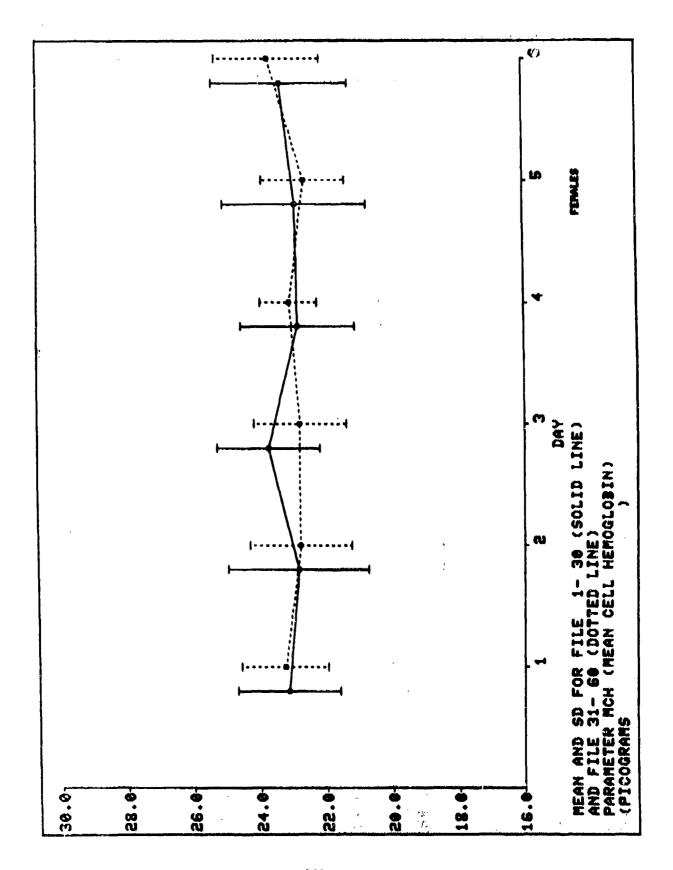






Property of

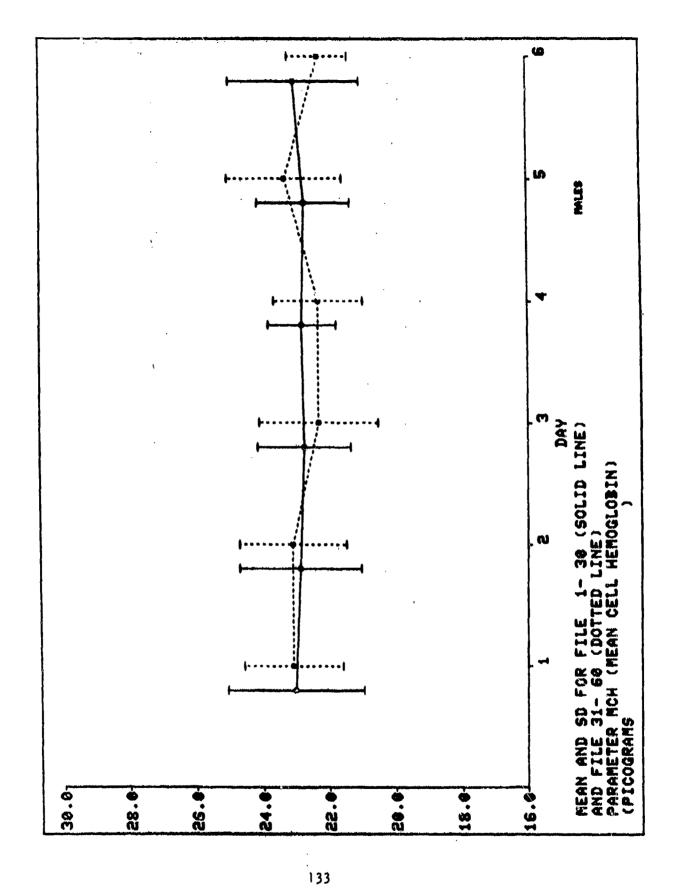




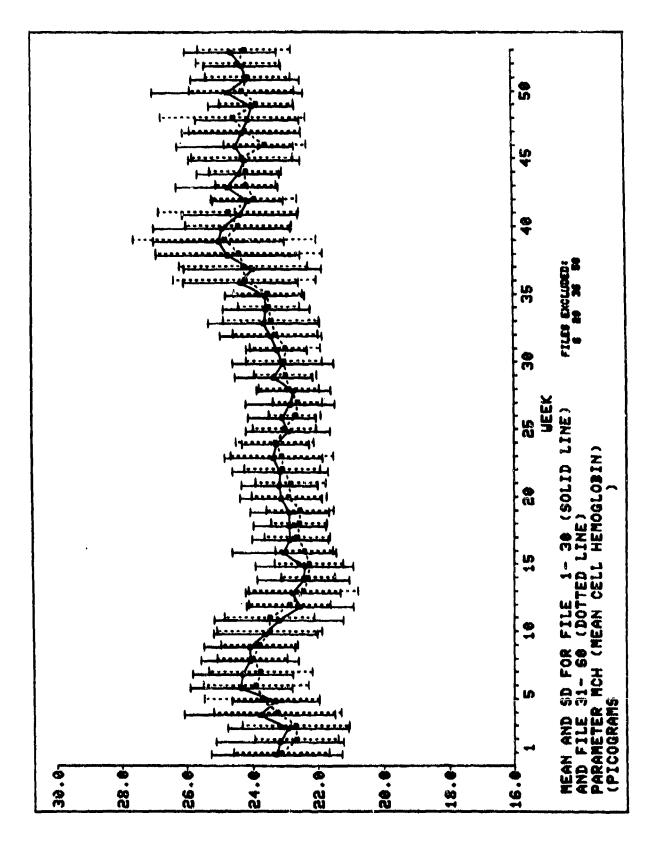
فكعلاه الاعاد هلاهم كالكارات وهيقيس أمطع متارا سيب كالسام كالسام كالمياه وميال ويضيا الشيفية فراسطها الساءة وسامتها فالسامة

中的人员,不是这种人的人,我们就是这种的人的人,我们就是这种人的人,我们就是这种人的人,我们也是这种人的人的人,也是这种人,也是这种人的人,也是这种人的人,也是这种人,也是

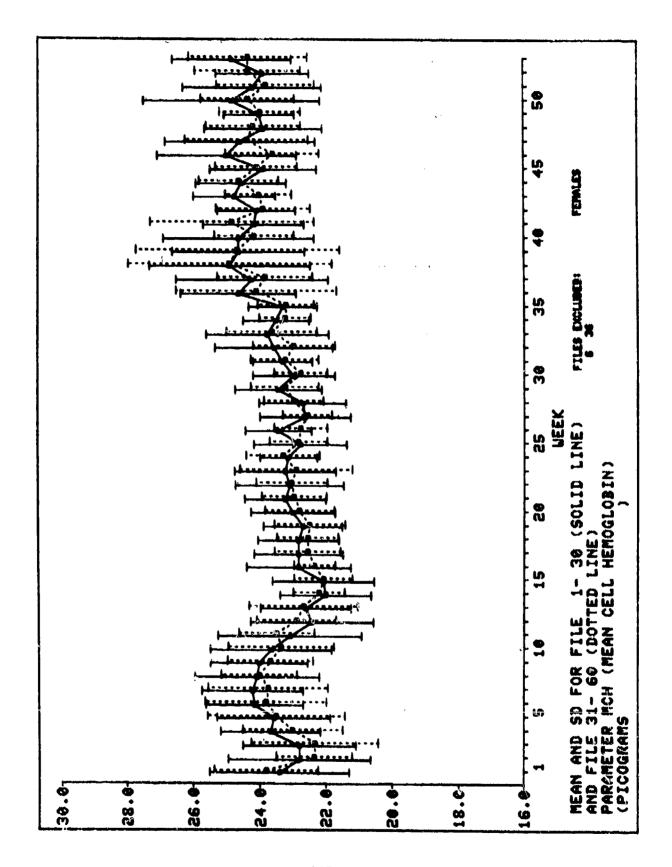
Photo Comment of the Principle of the control of the control

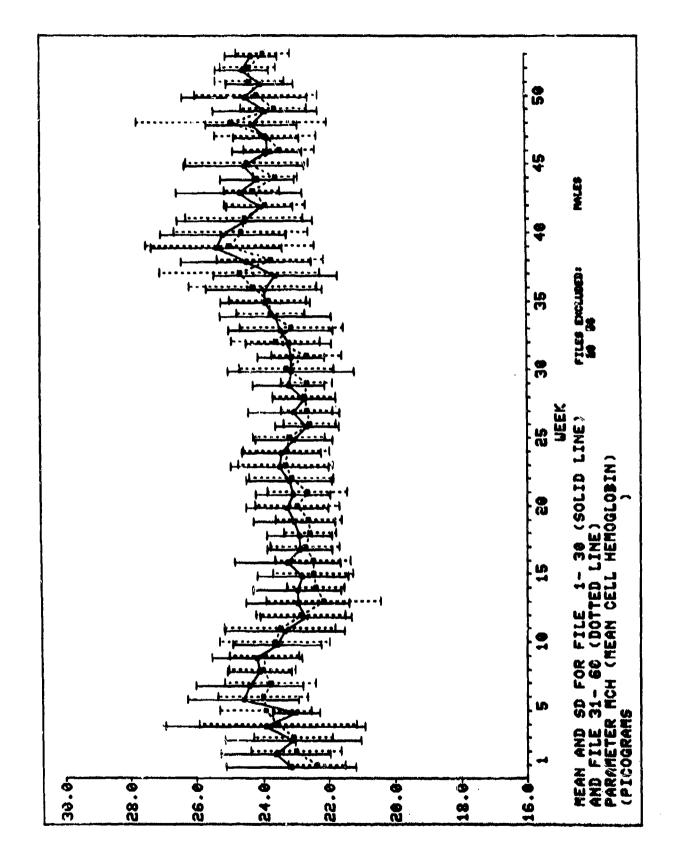


というないのでは まくまる

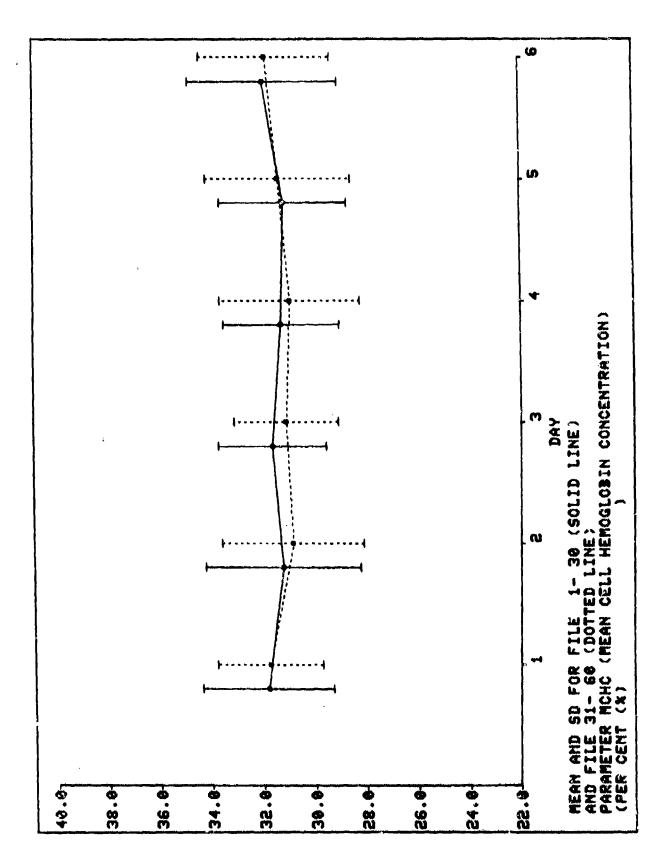


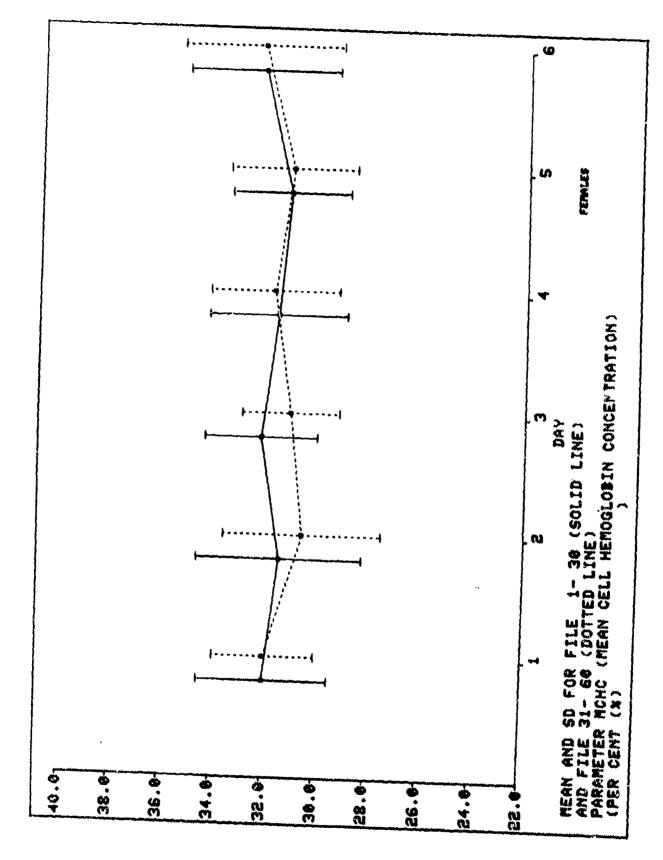
 $\sum_{i=1}^{n} \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \right) = \frac{\partial^2 \mathcal{N}_{i}}{\partial x_i} \left( \frac{\partial^2 \mathcal{$ 

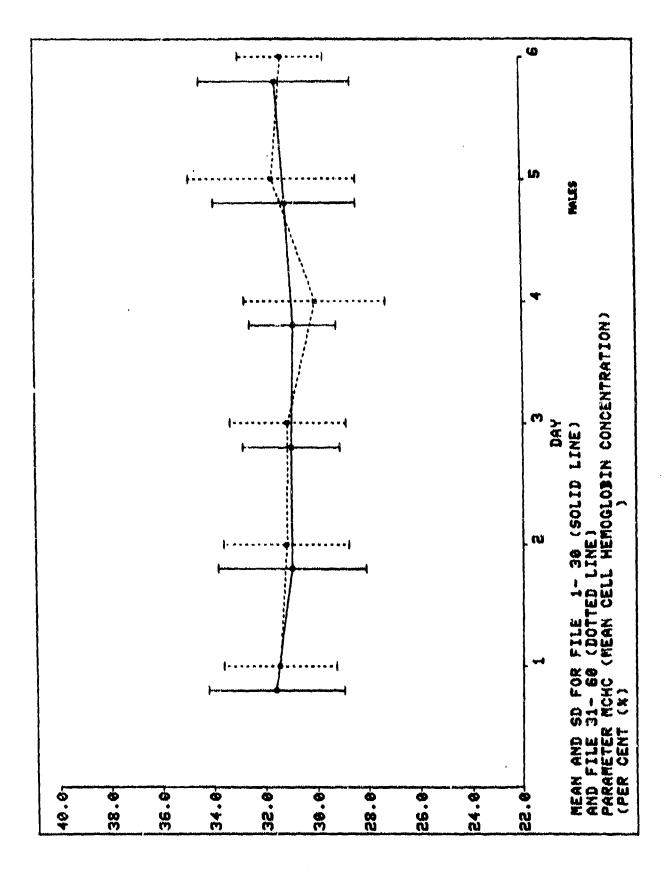


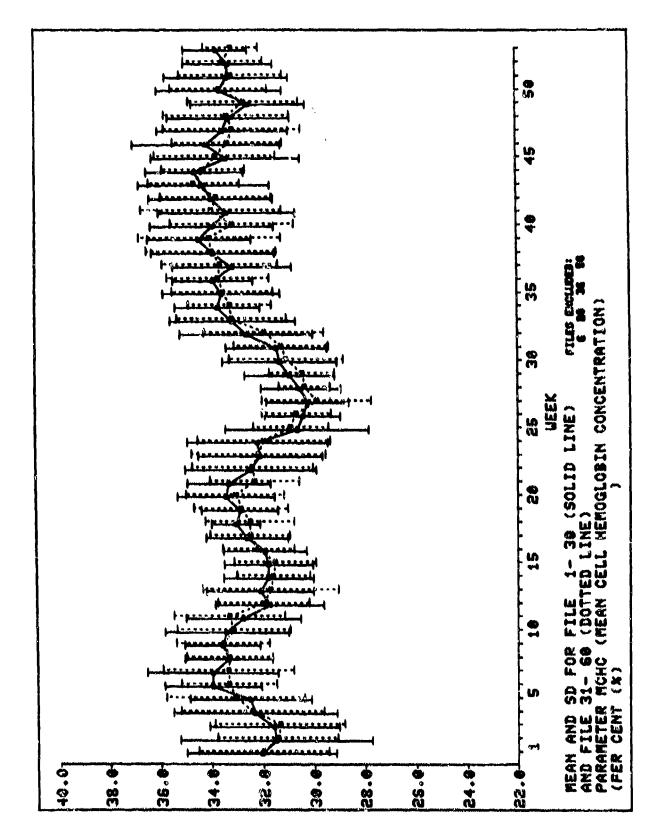


Standard Bank States - Charles

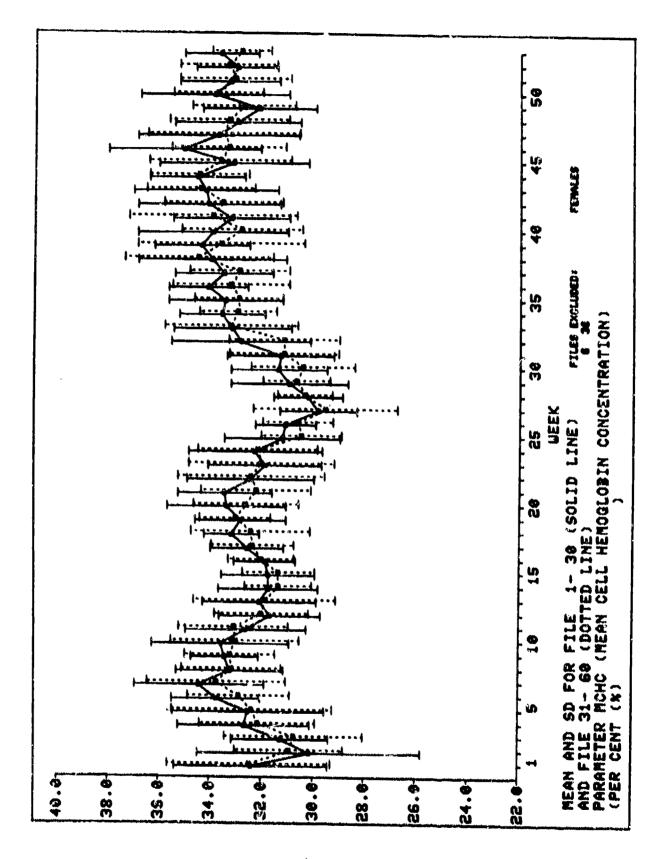


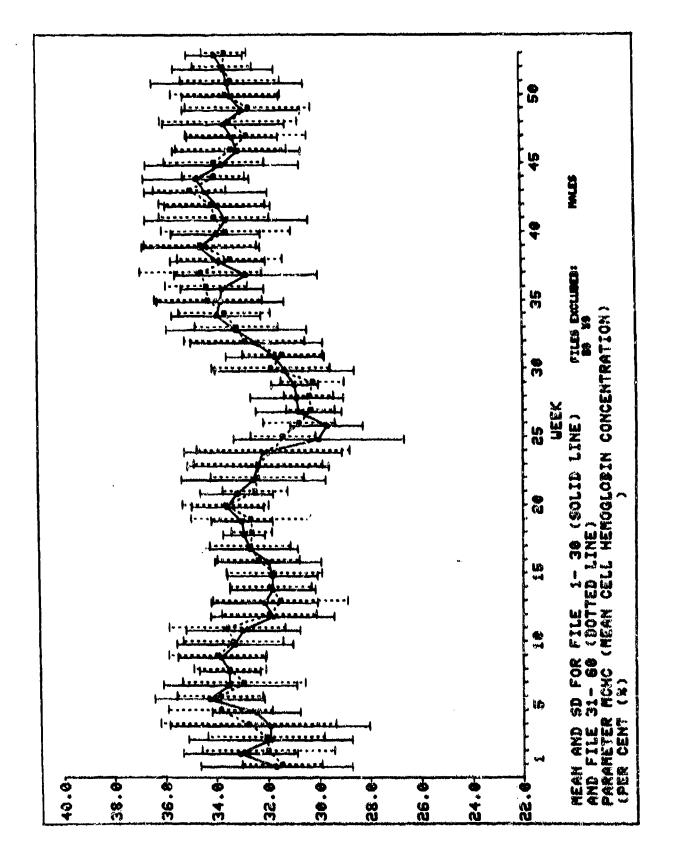




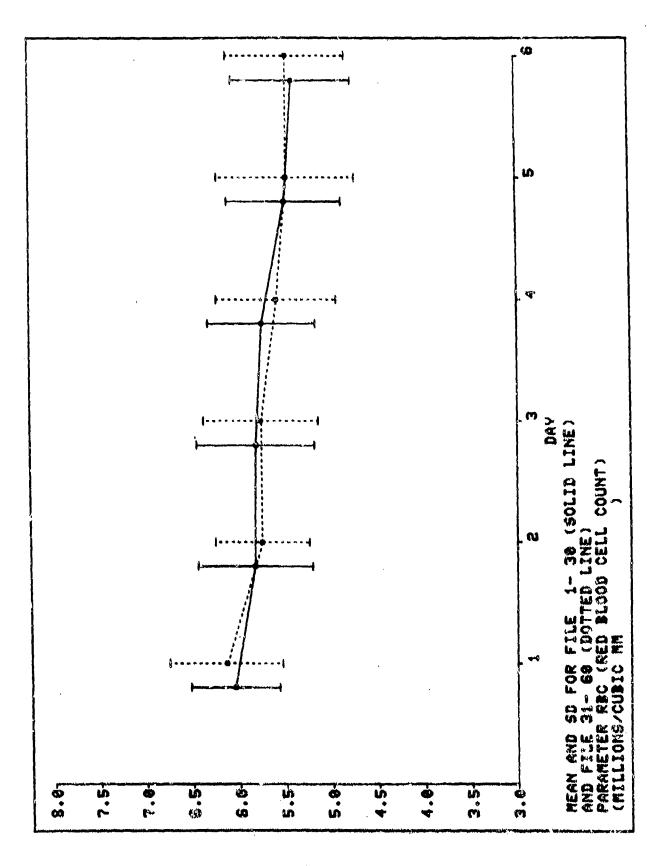


THE RESIDENCE AND A SECRETARIAN CONTROL OF THE SECRETARIAN AND A SECRETARIAN AND ASSESSION AND A SECRETARIAN AND A SECRE

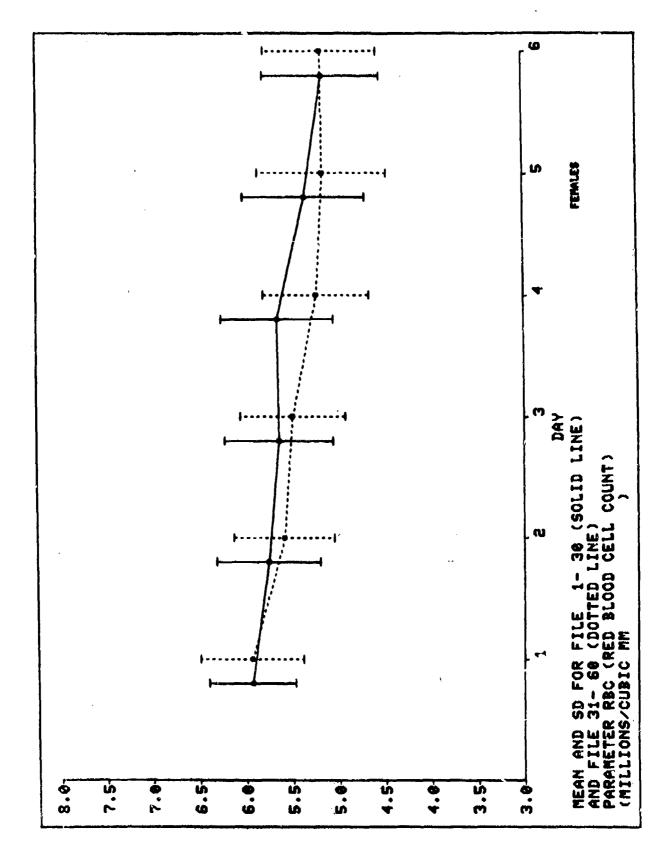


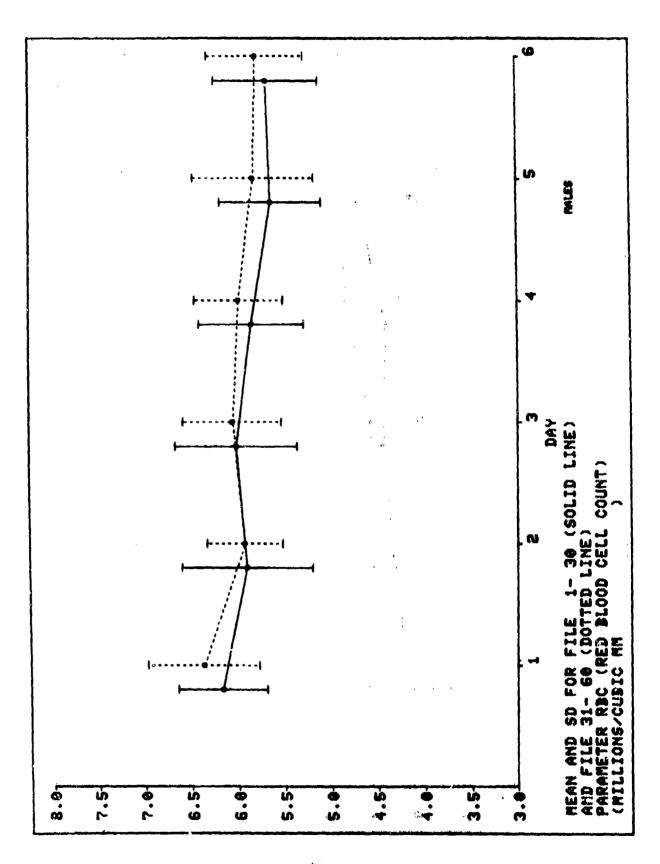


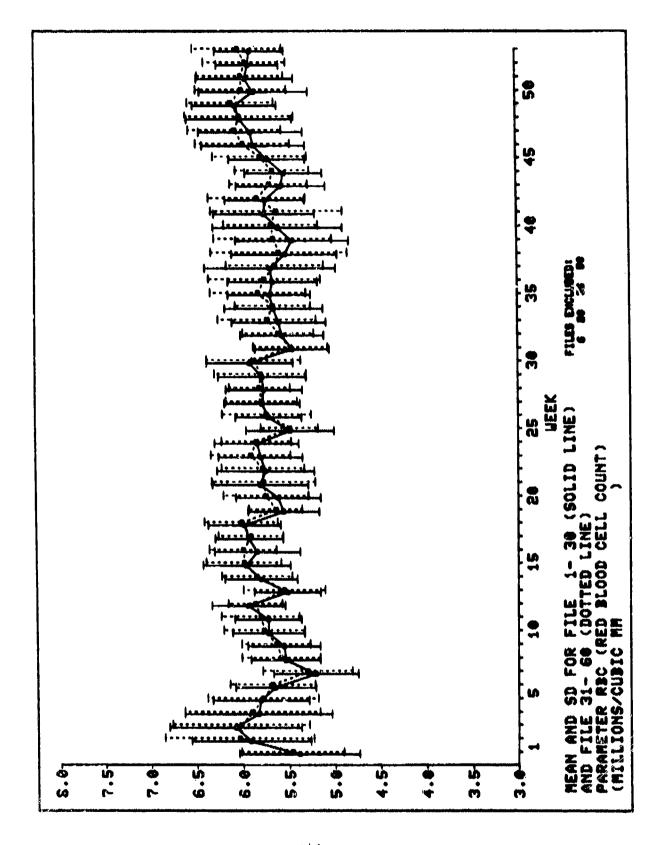
ないないのでは、これでは、これは 100mm なっては 100mm となっているというとなるとなって、100mm になっているというというない。 100mm になっている 100mm に

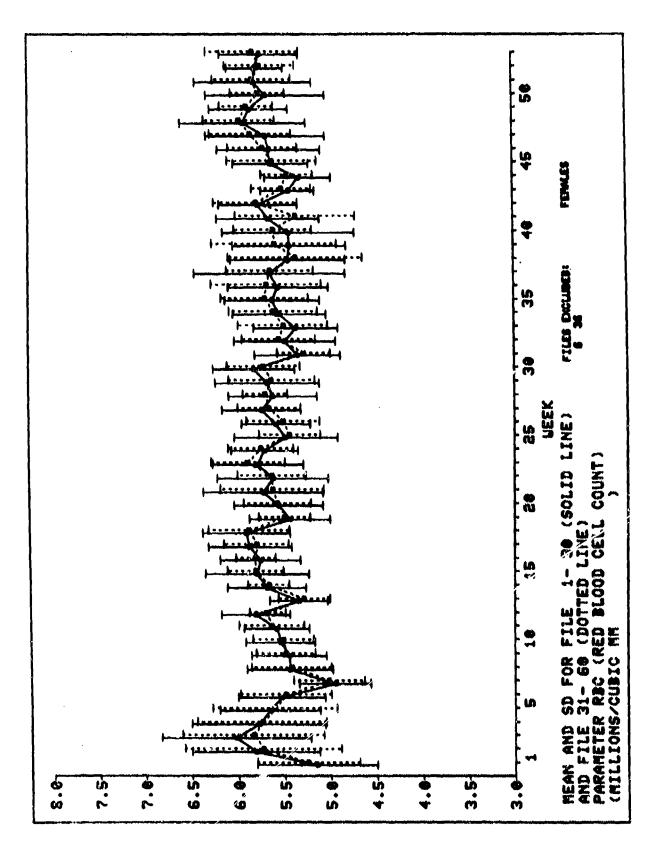


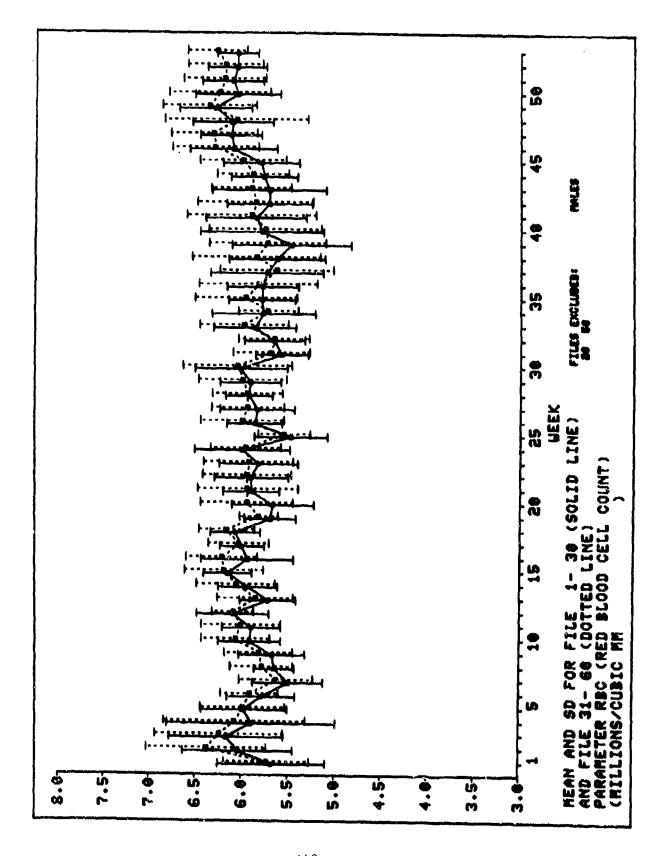
THE PROPERTY OF THE PROPERTY O



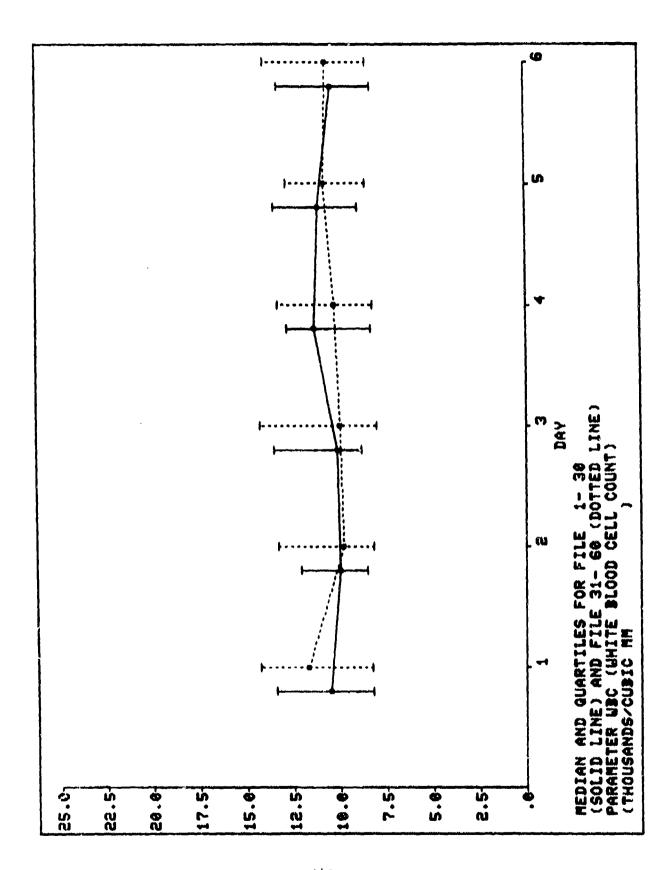


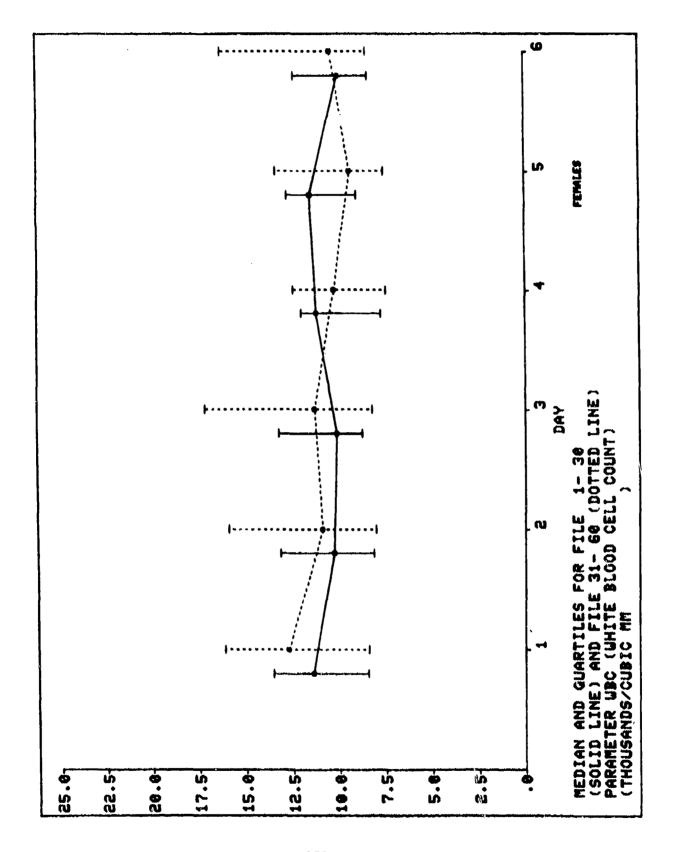


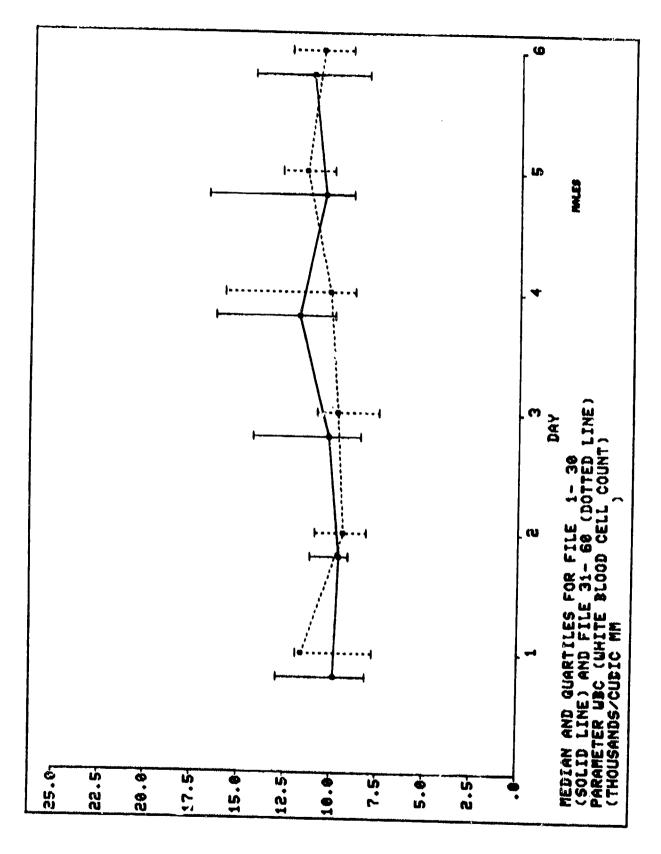


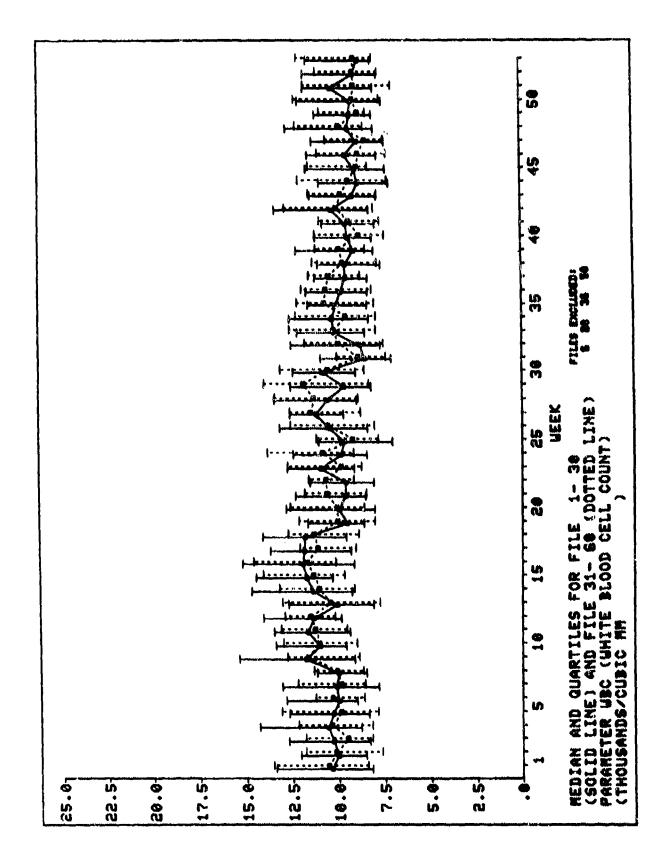


PSECOLO SECURITION

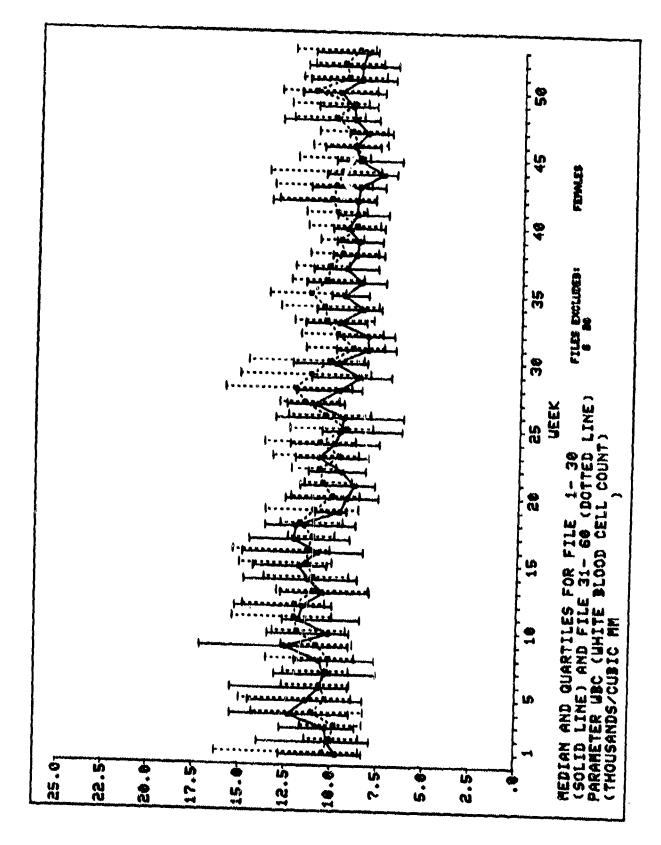


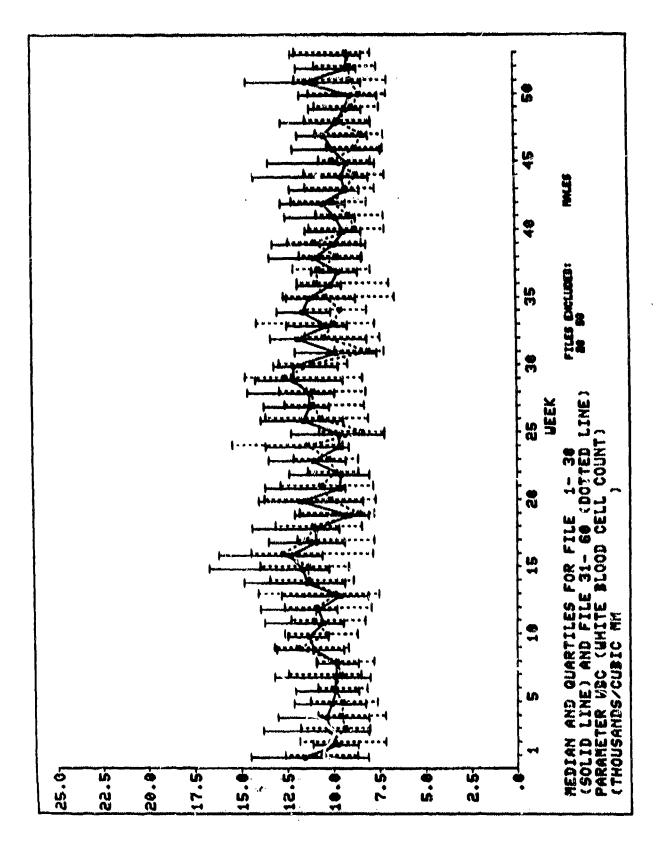


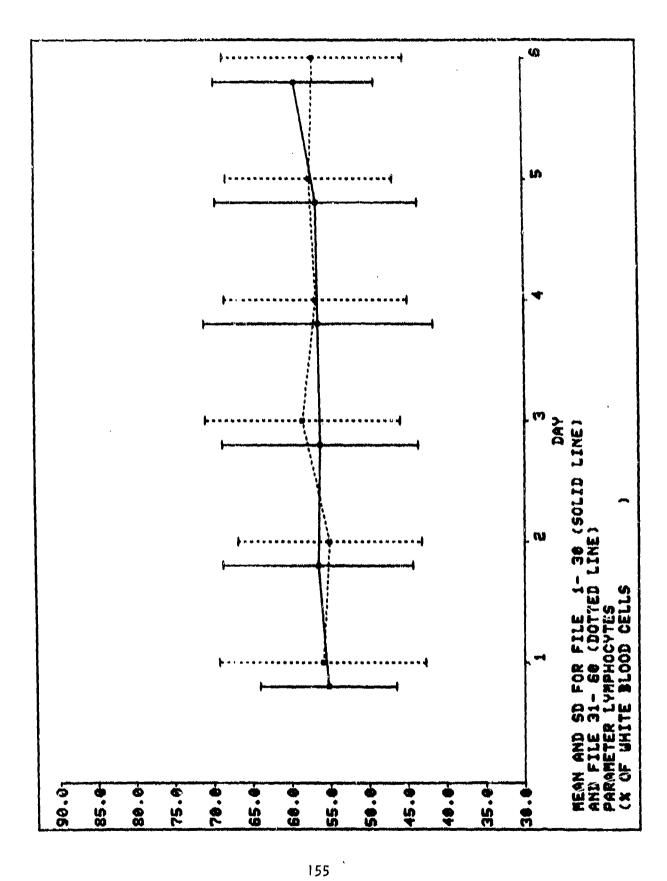


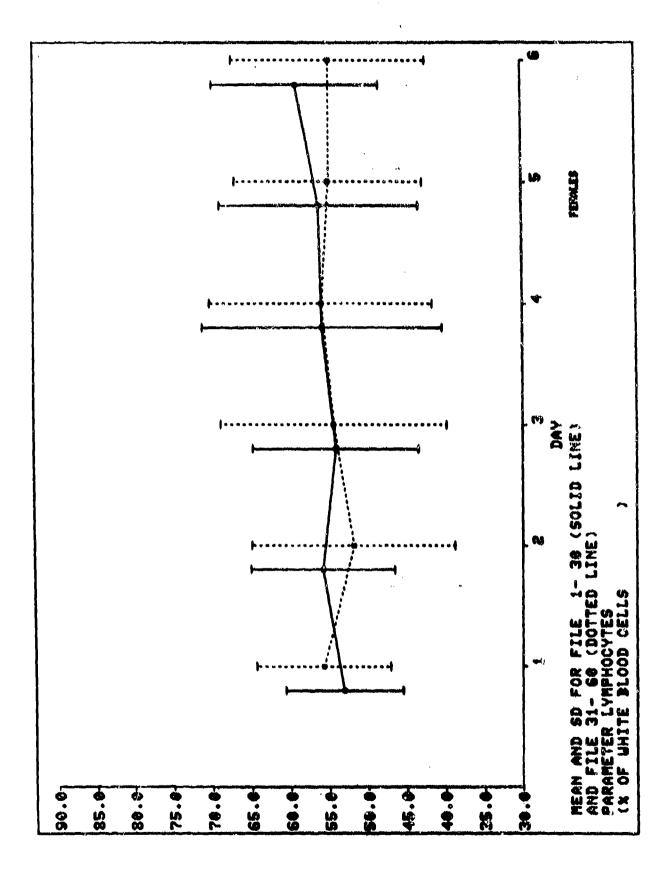


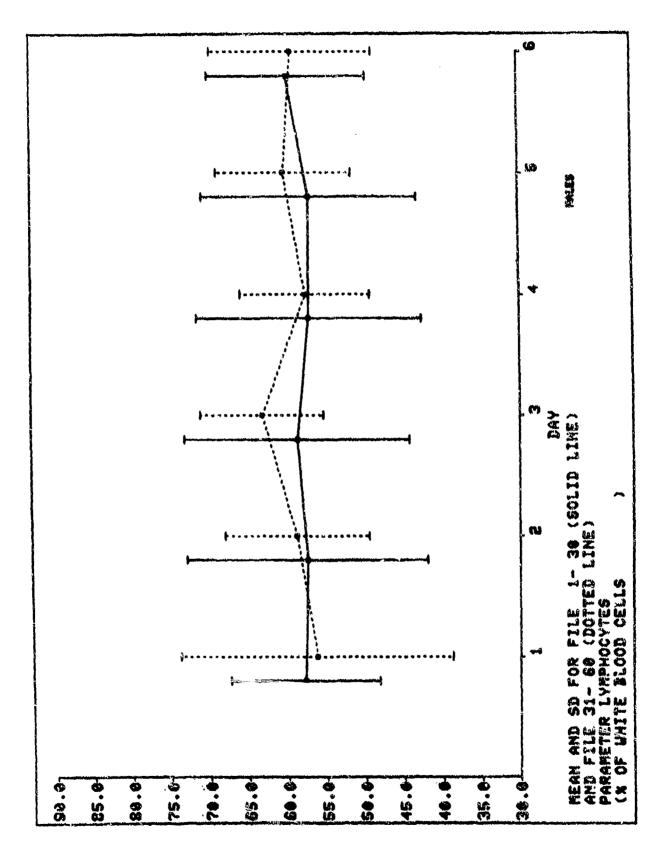
据数据 100 mm 100

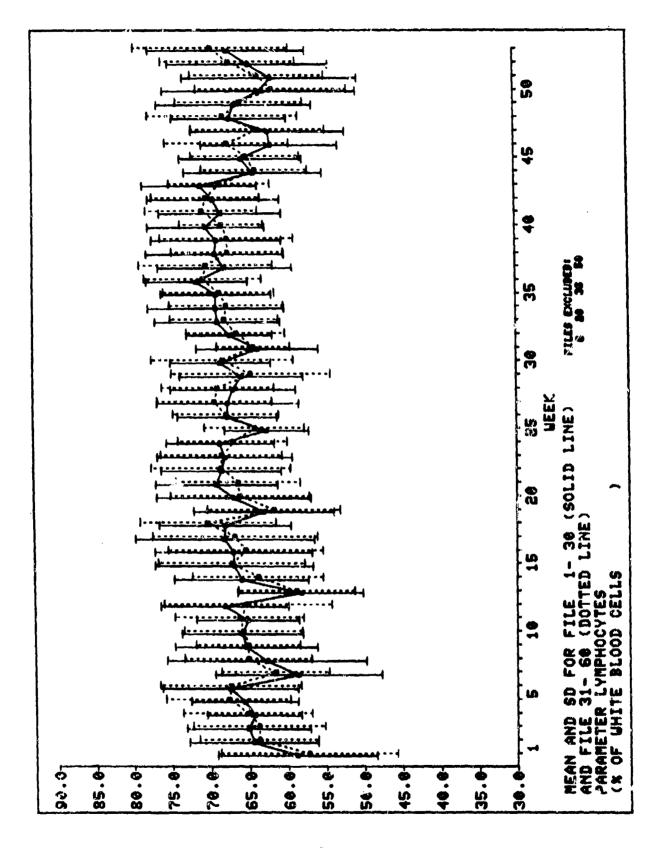


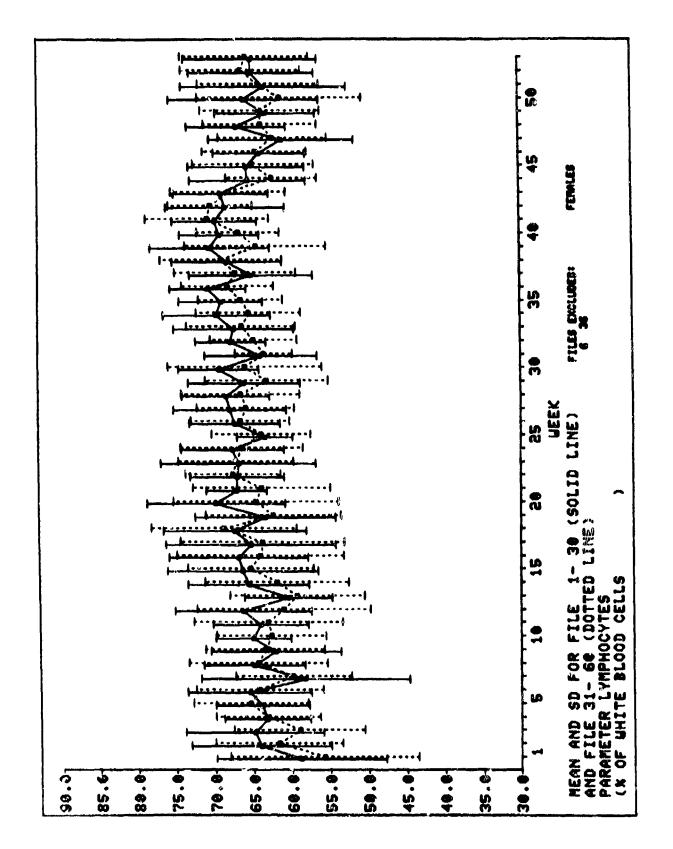


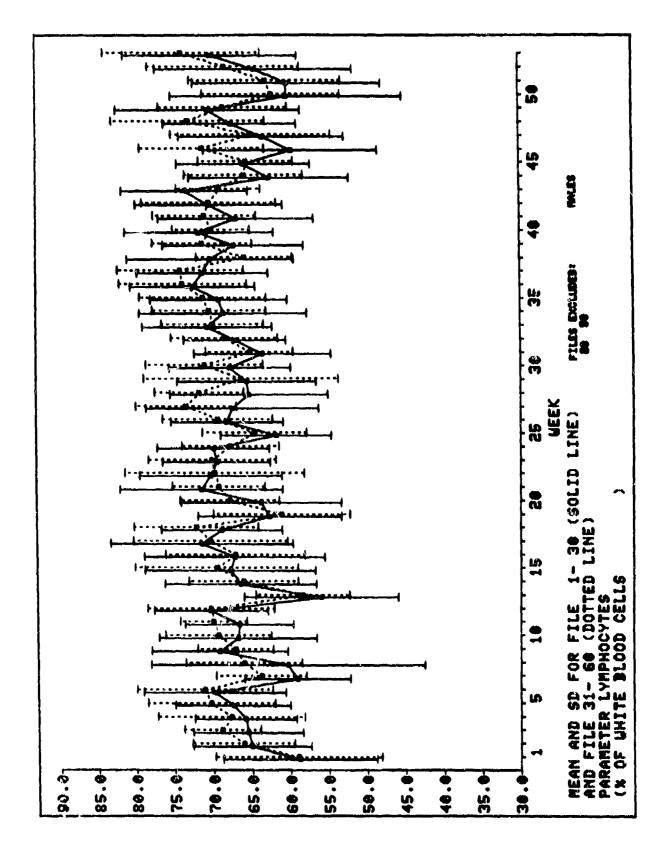


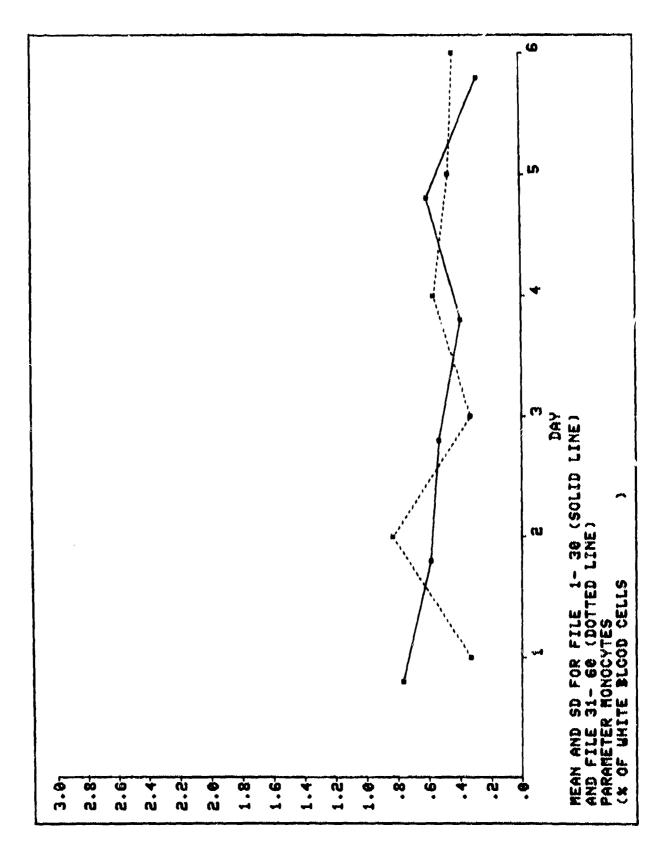


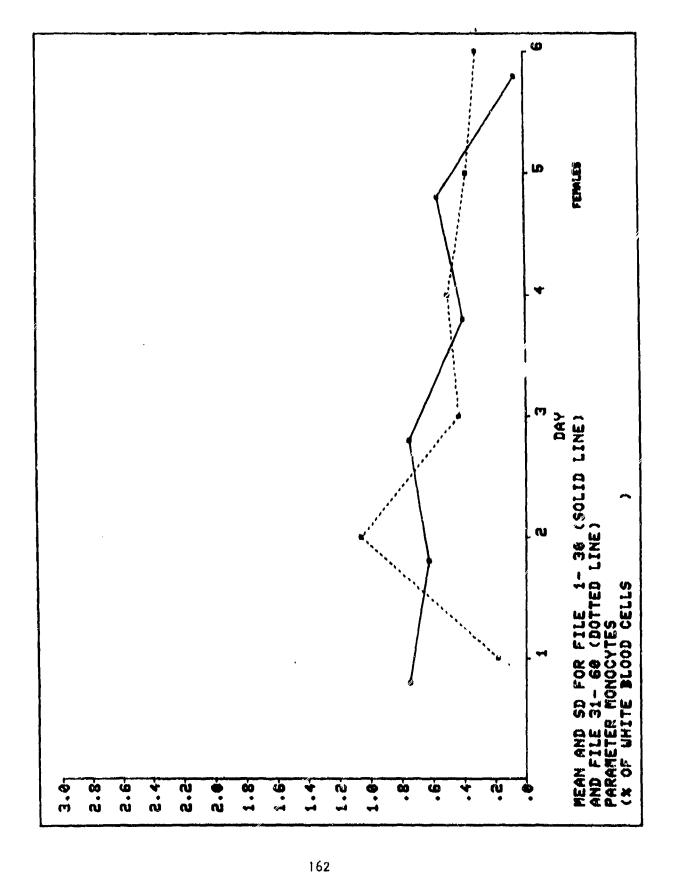


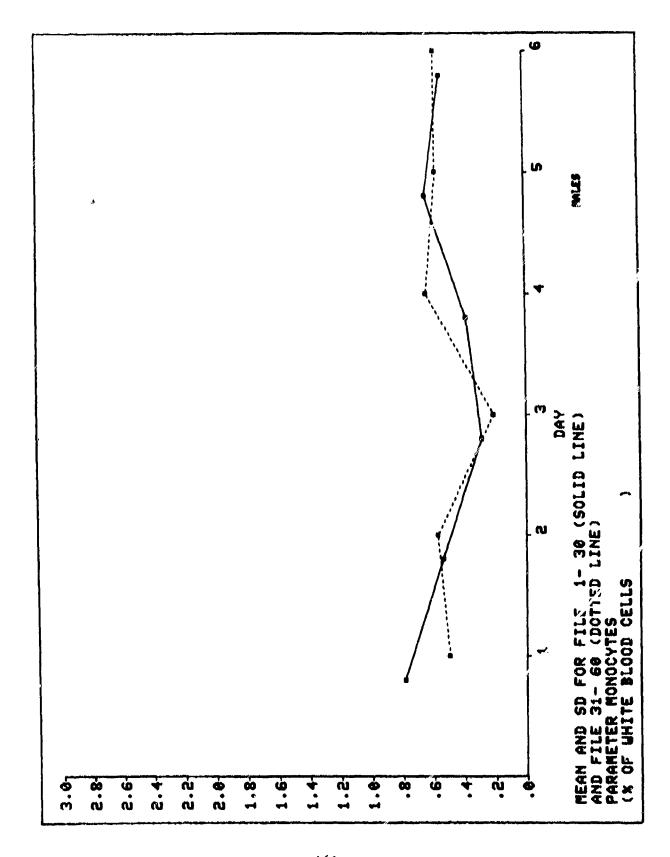


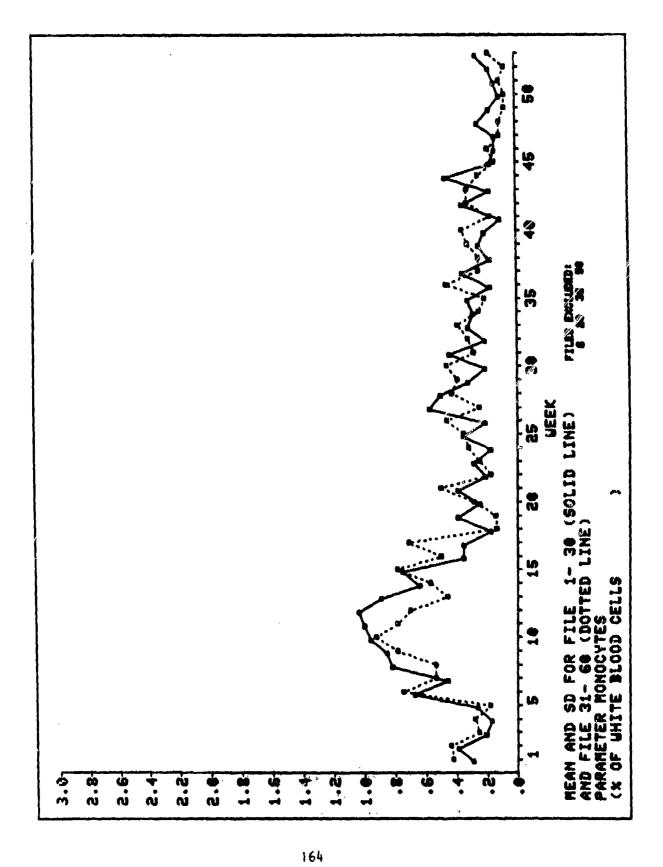


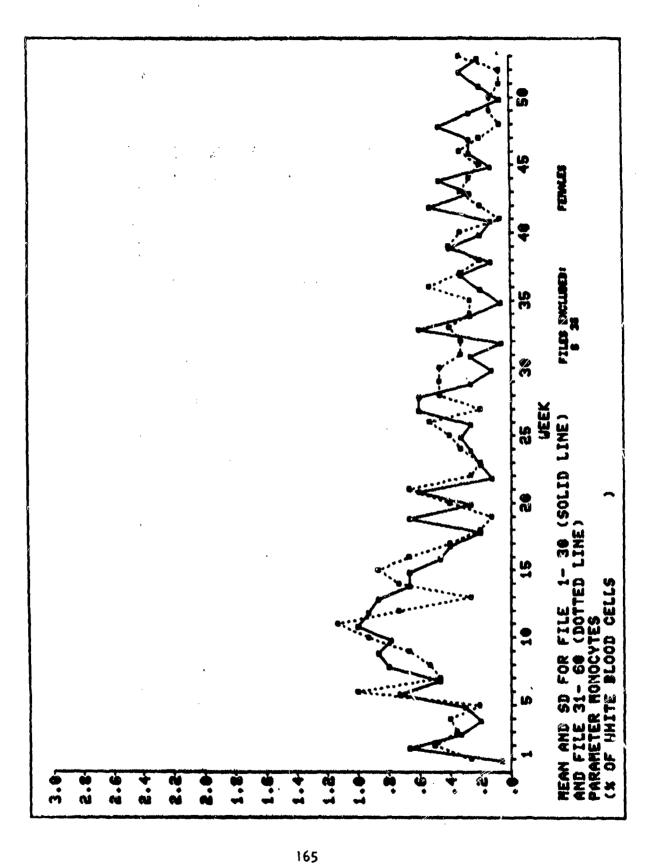


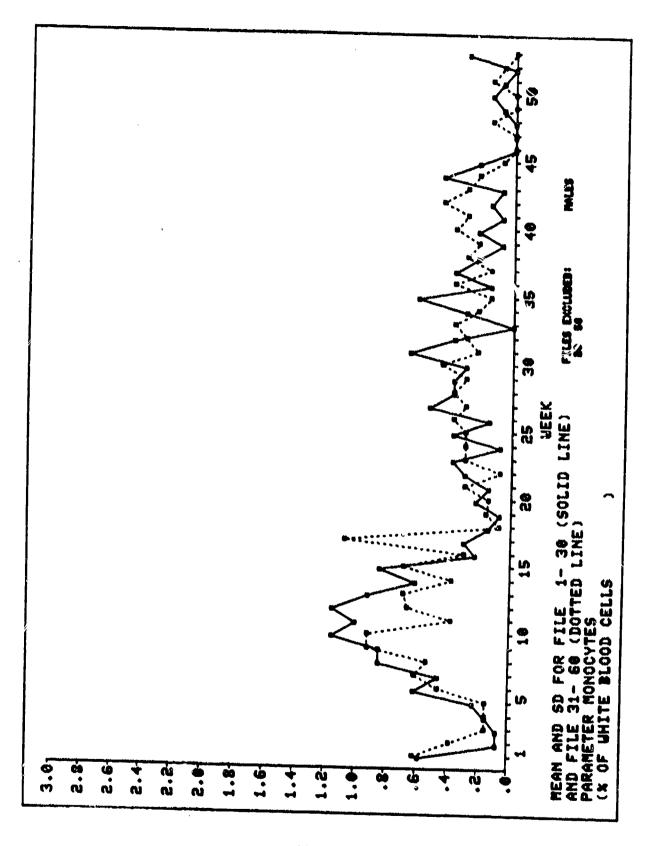


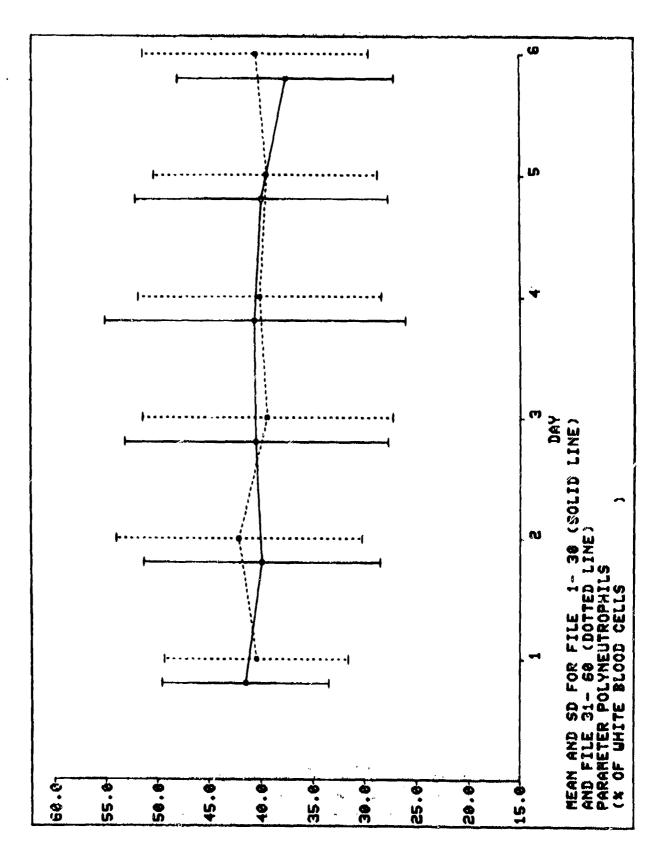


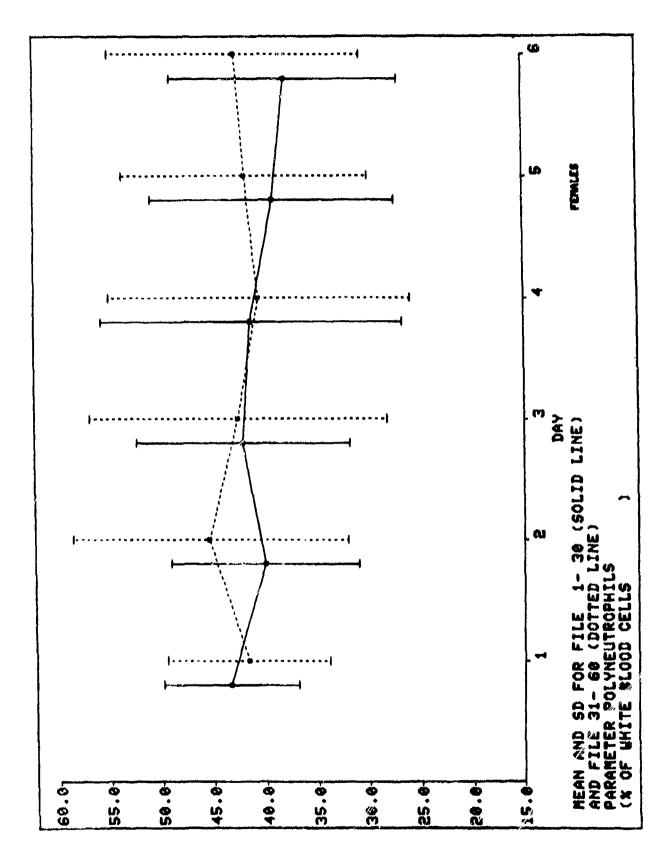


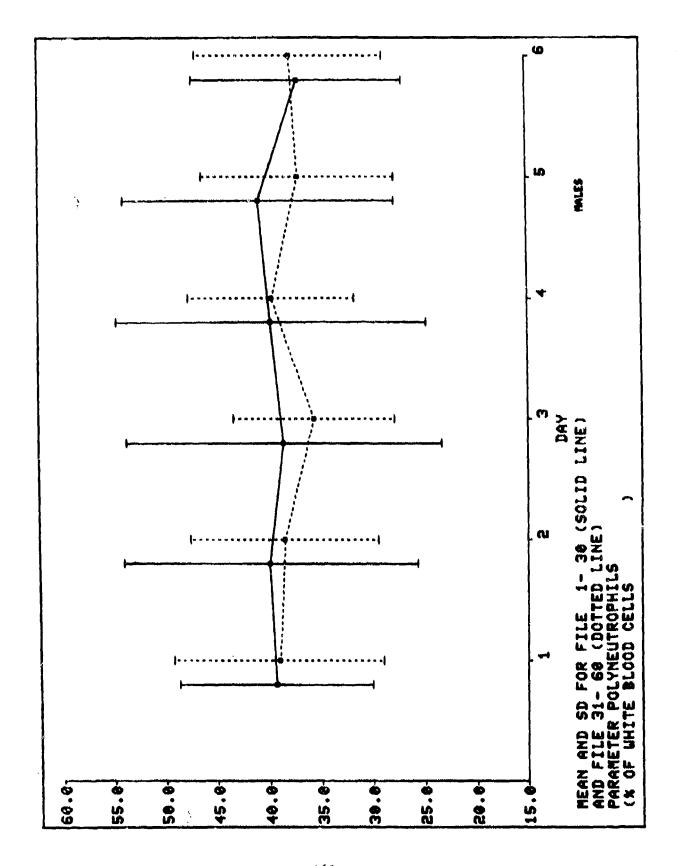


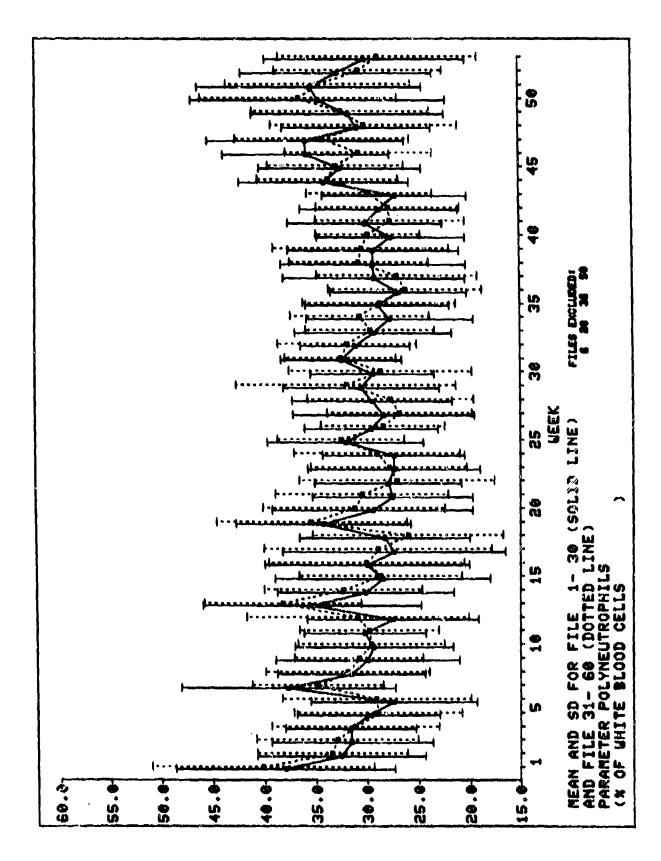


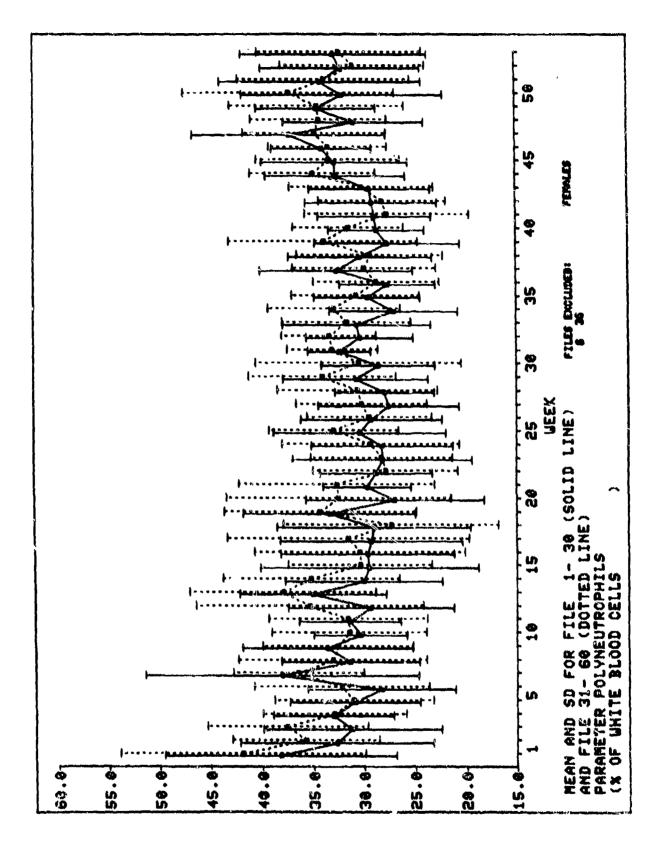


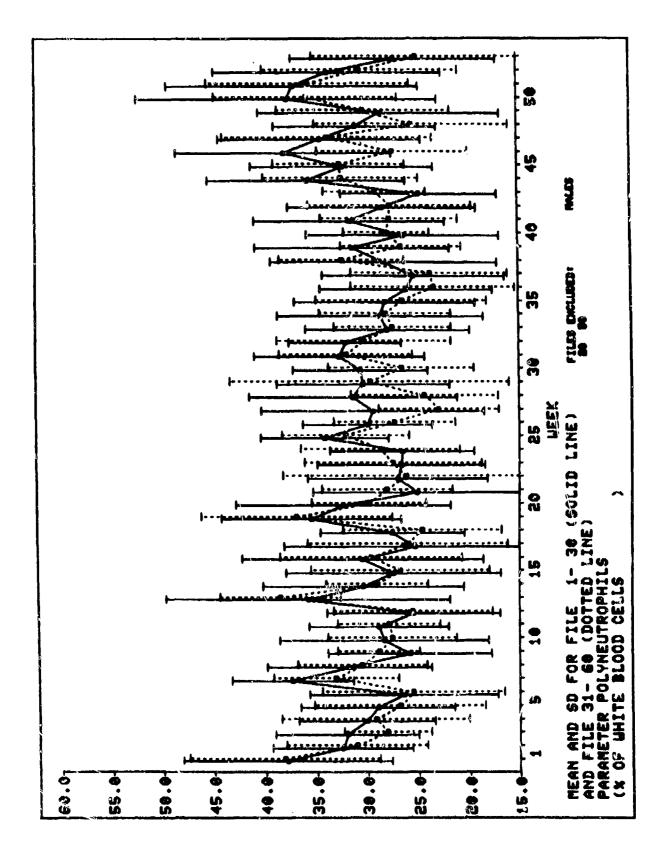




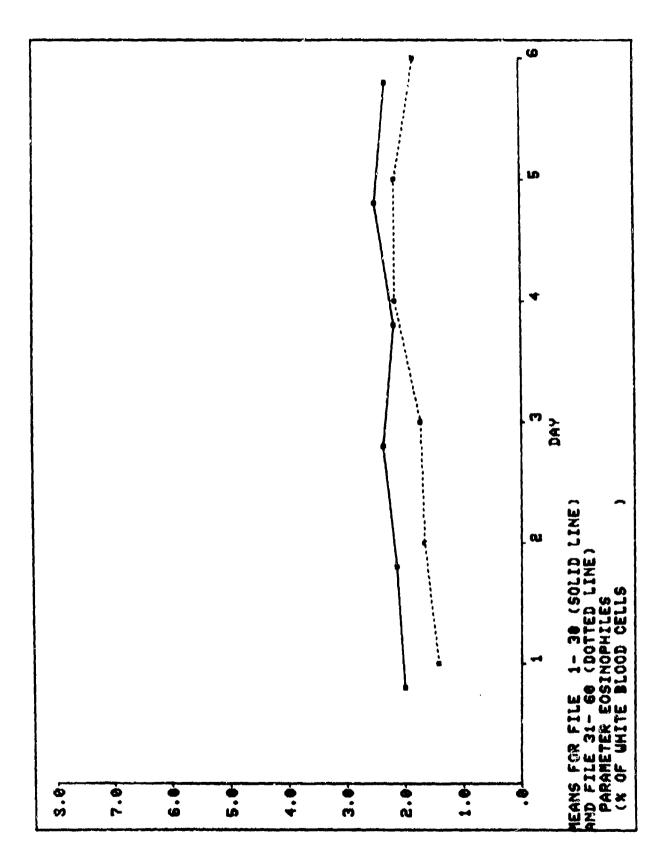


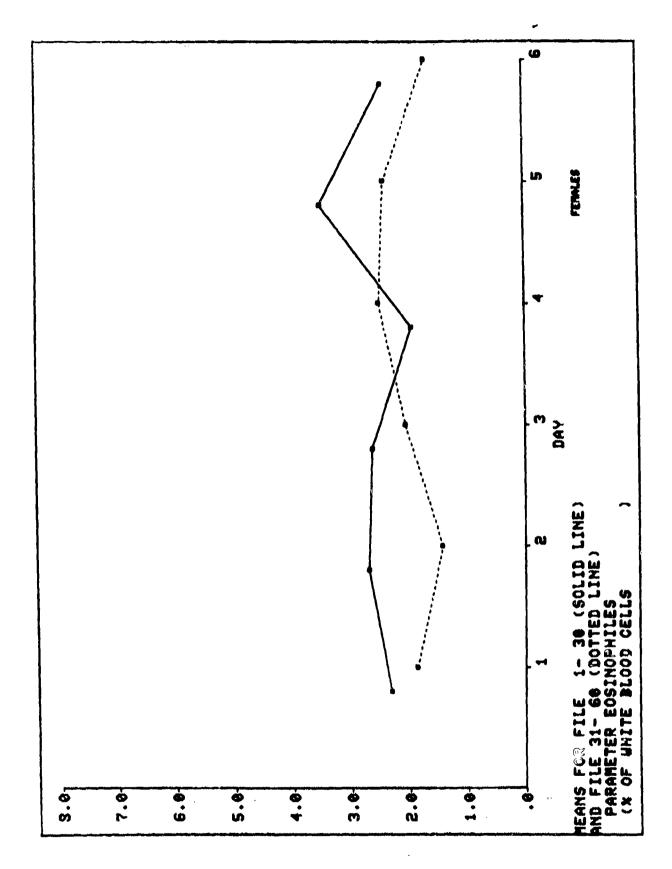




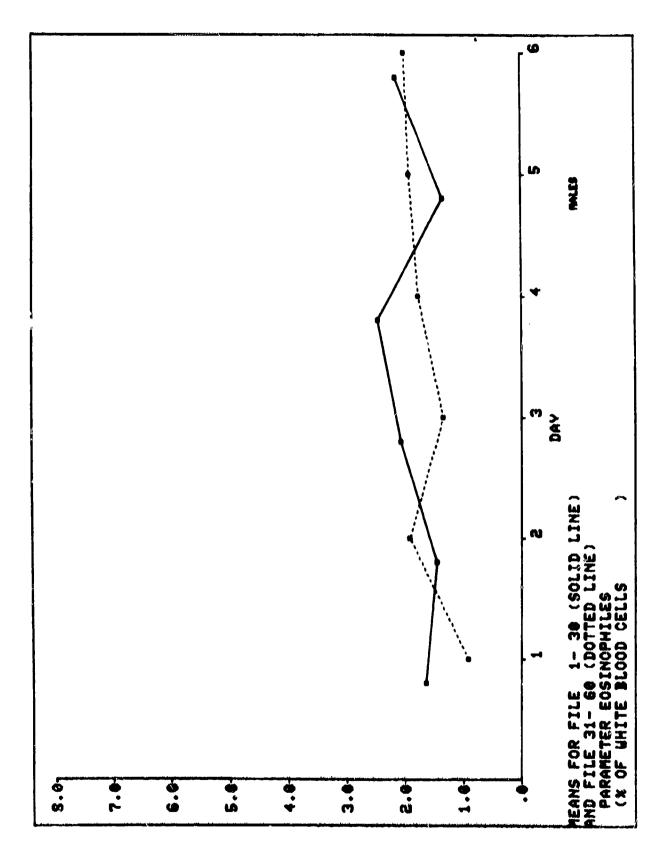


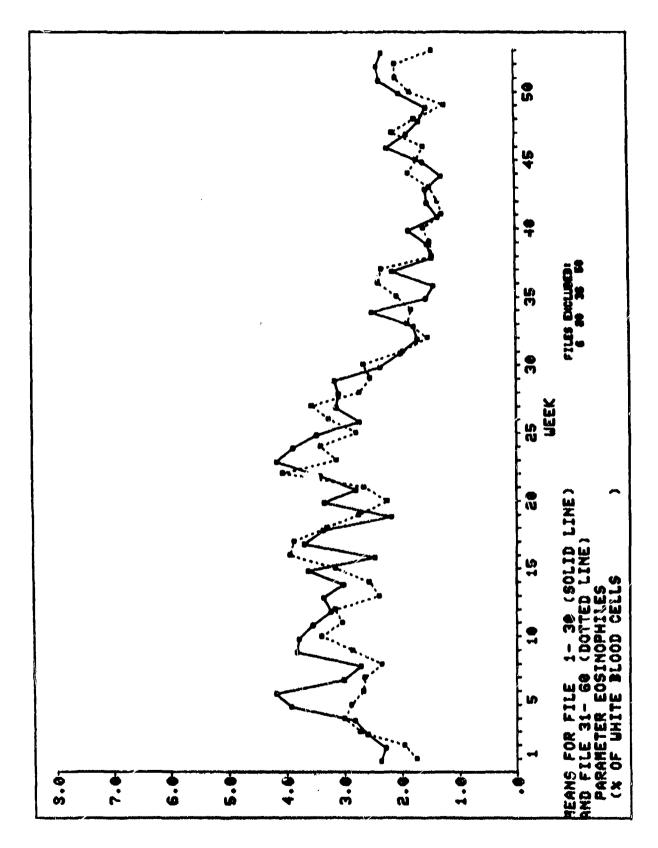
(0

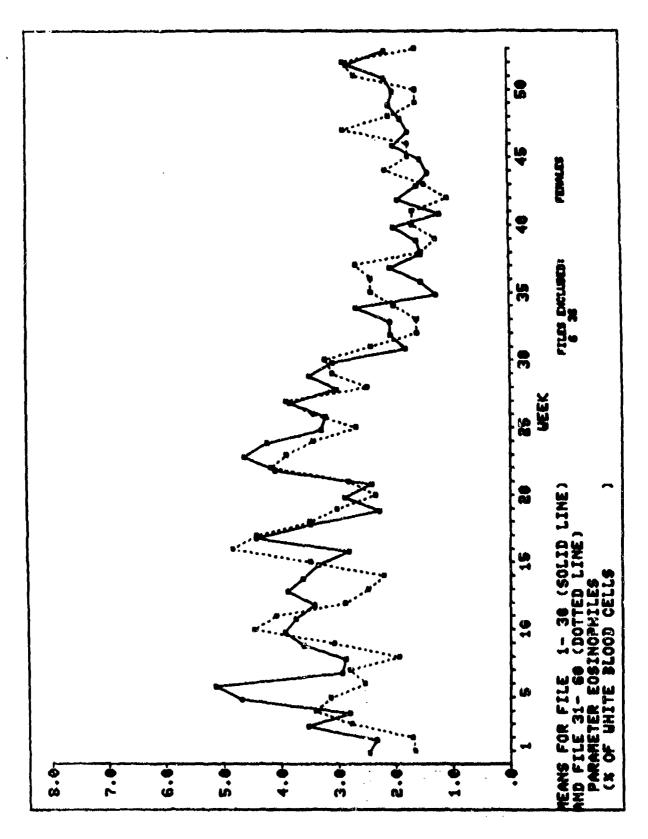


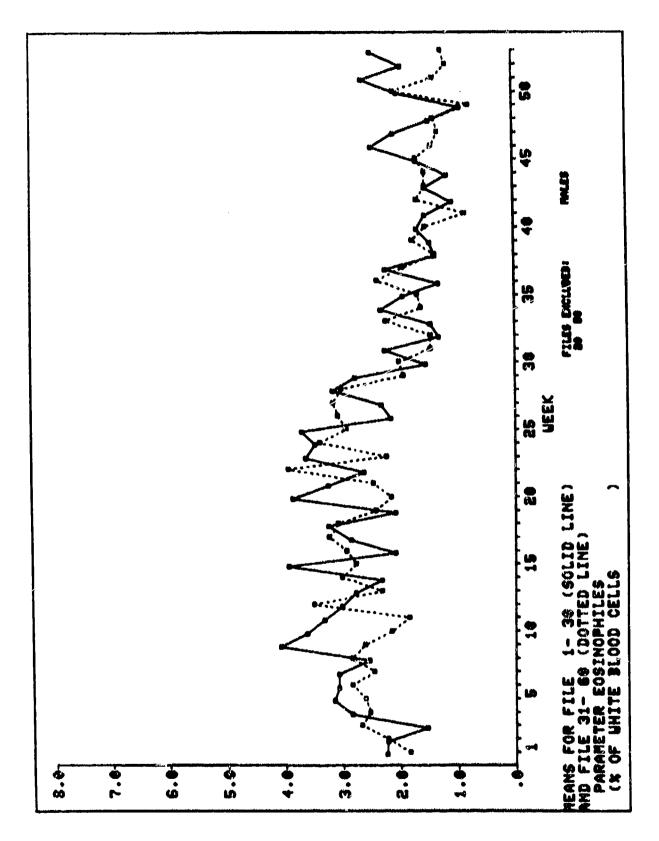


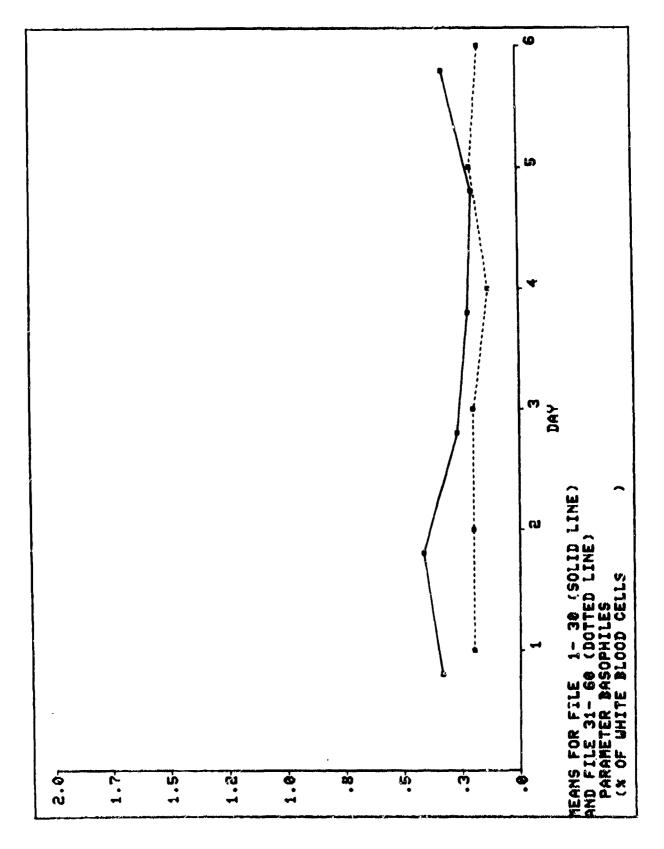
 $(g_{\bullet,\bullet}^{-1}(x)) = (g_{\bullet,\bullet}^{-1}(x)) + (g_{\bullet,\bullet}^{-1}(x))$ 

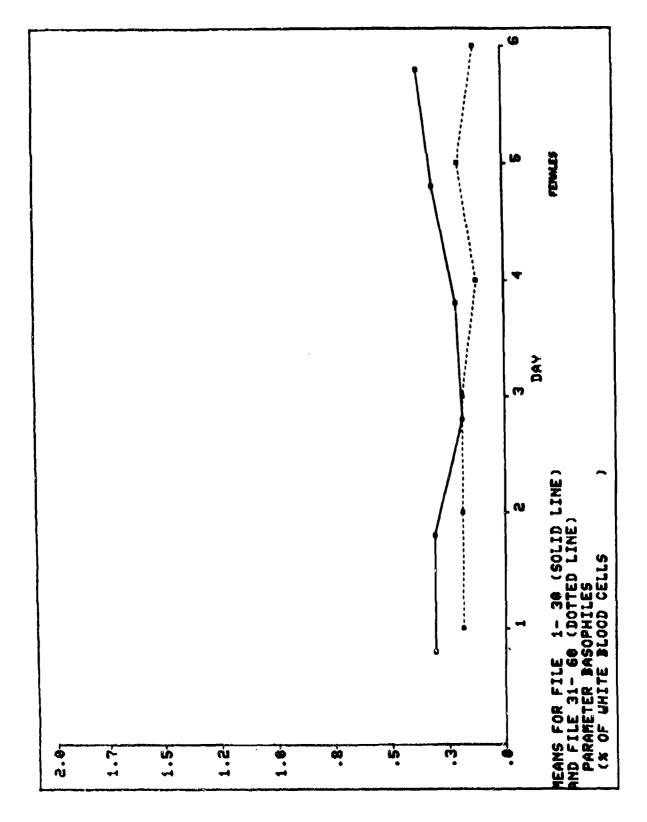




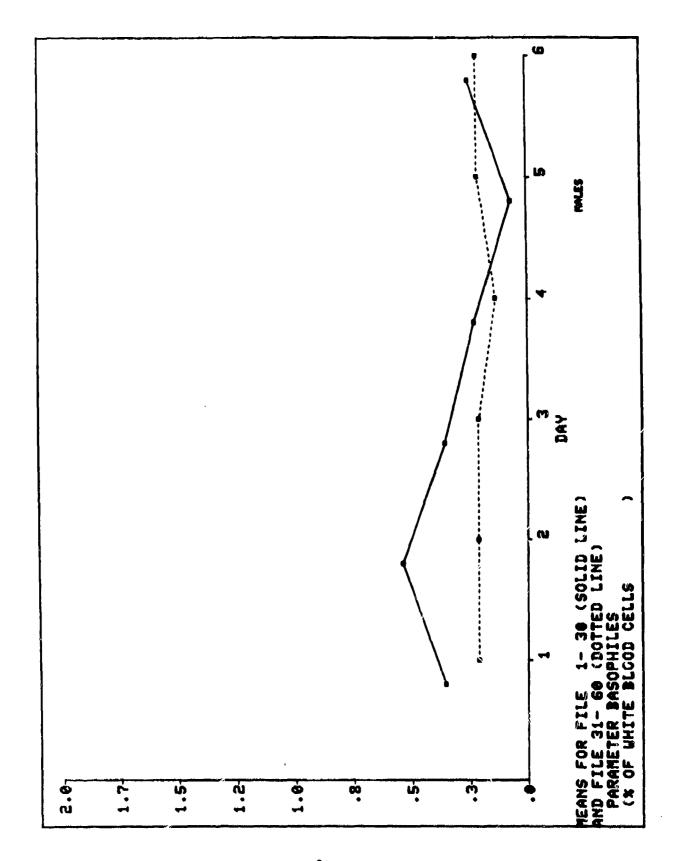


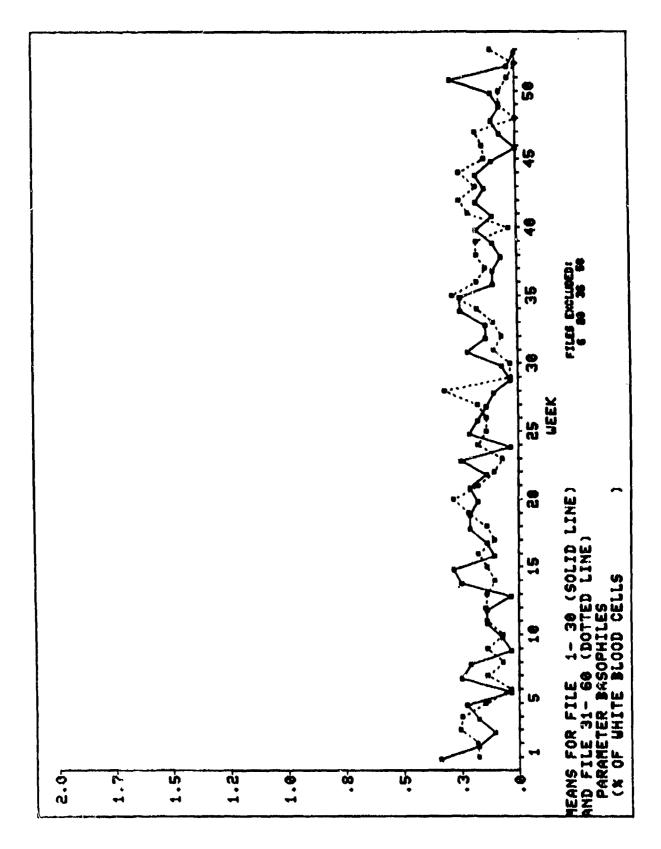


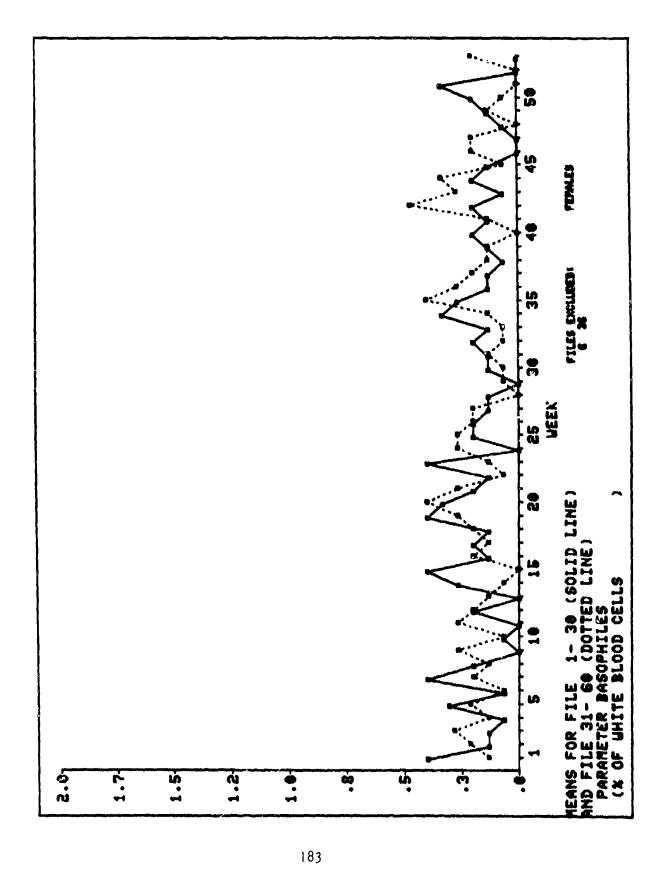


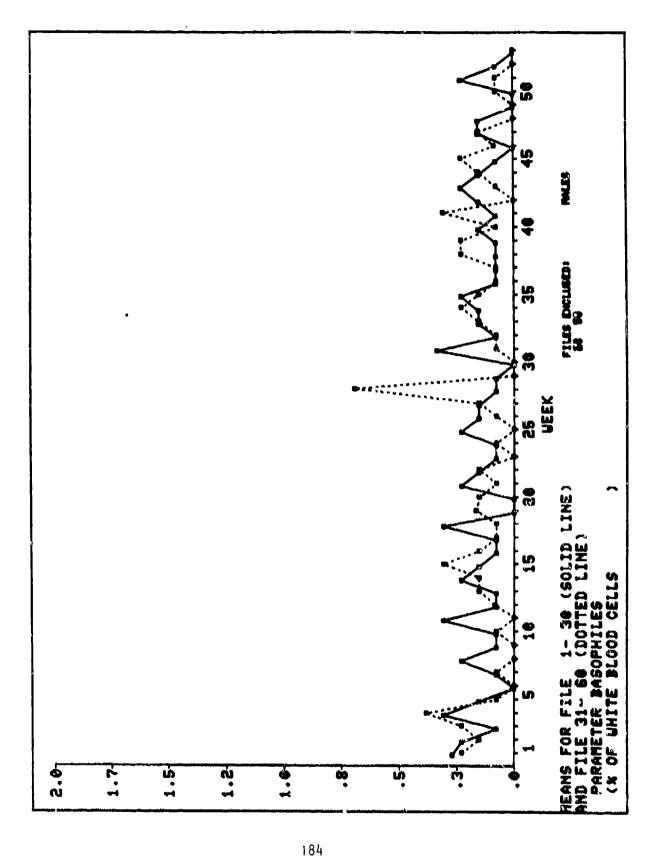


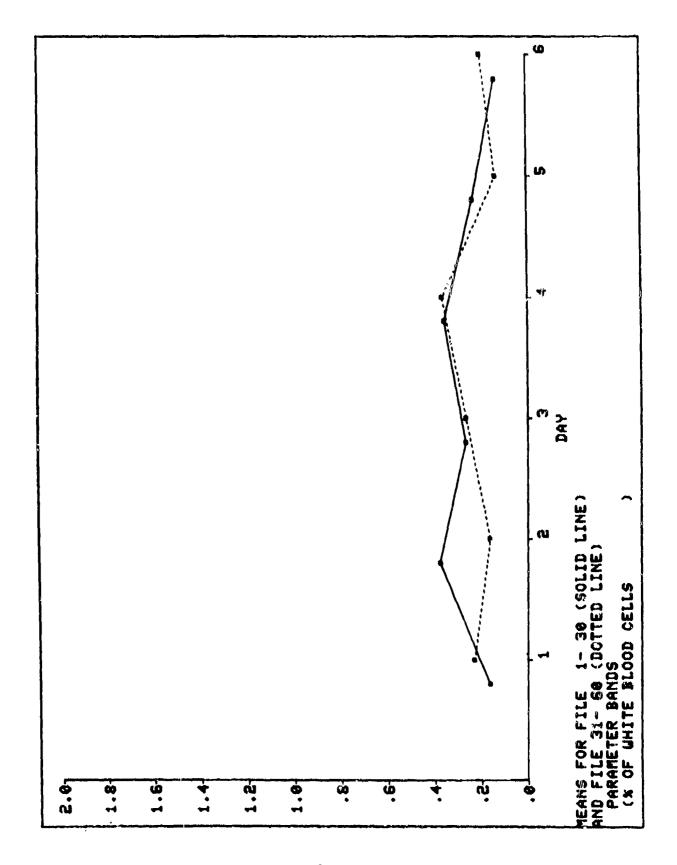
Secretary Company of the second

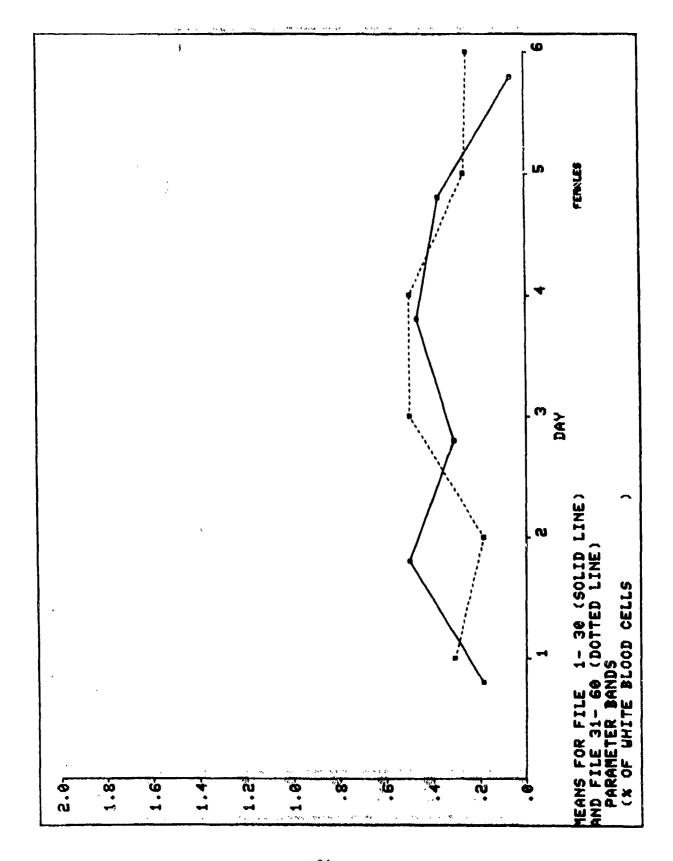


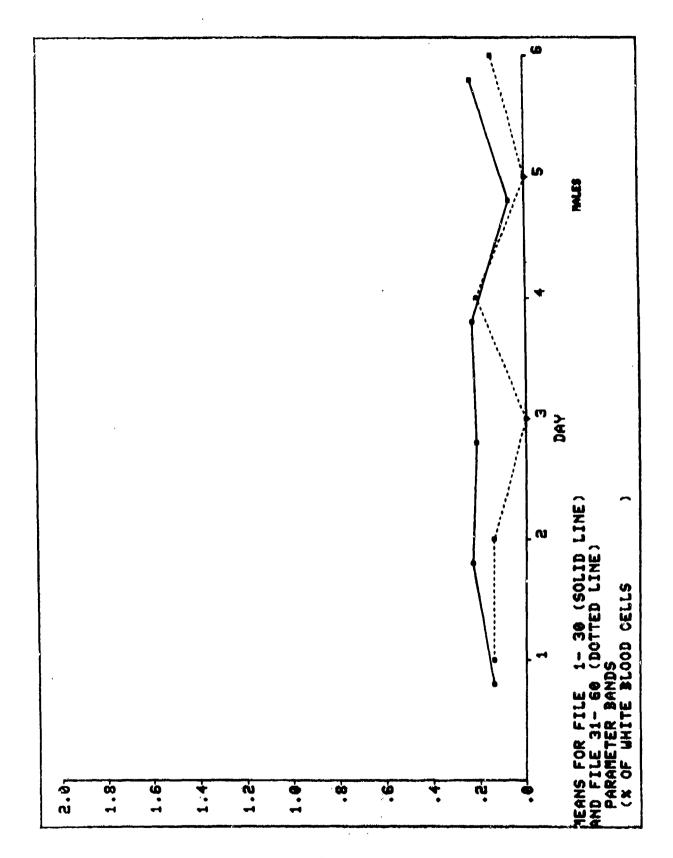


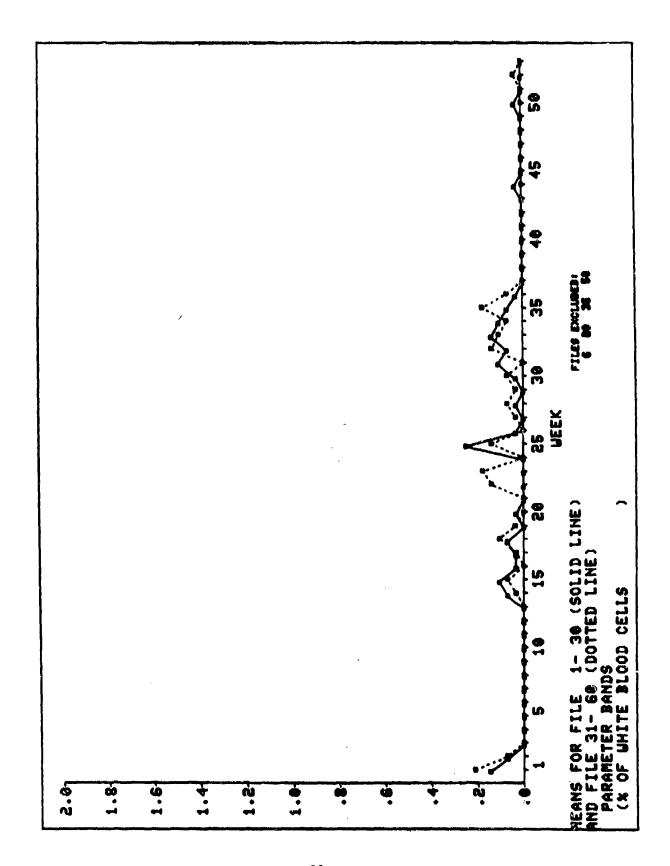






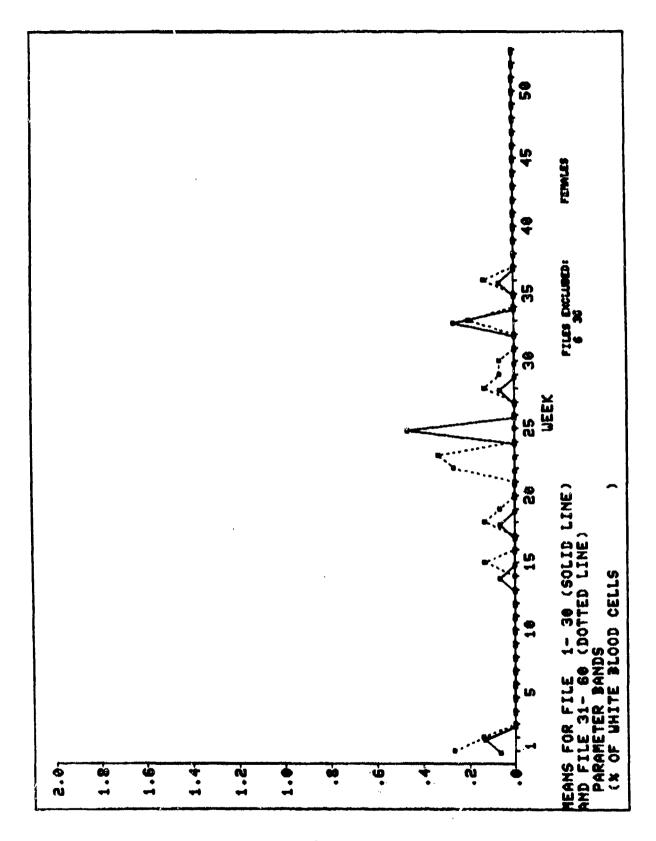


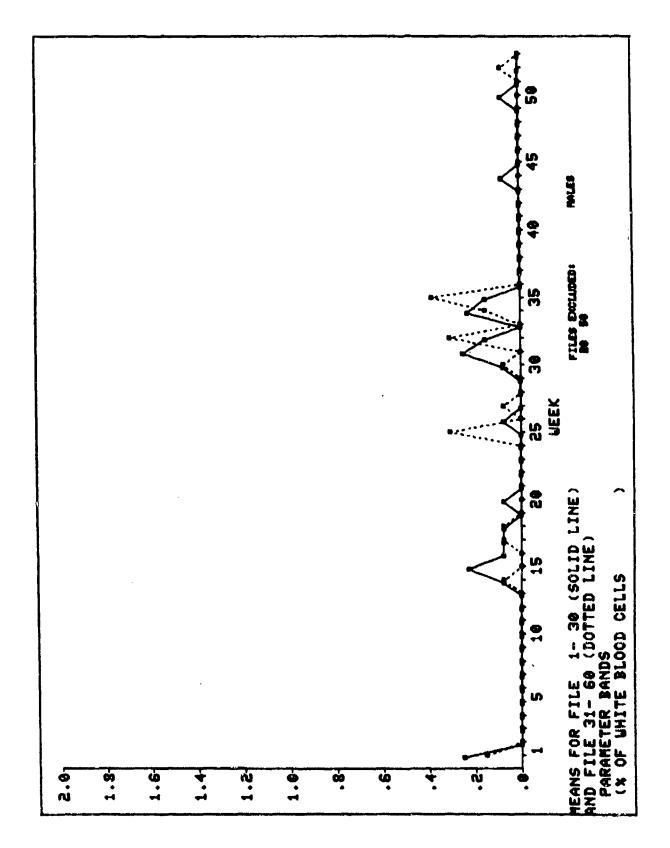




等的,我们就是这个人,我们就是这个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一个人,我们就是一

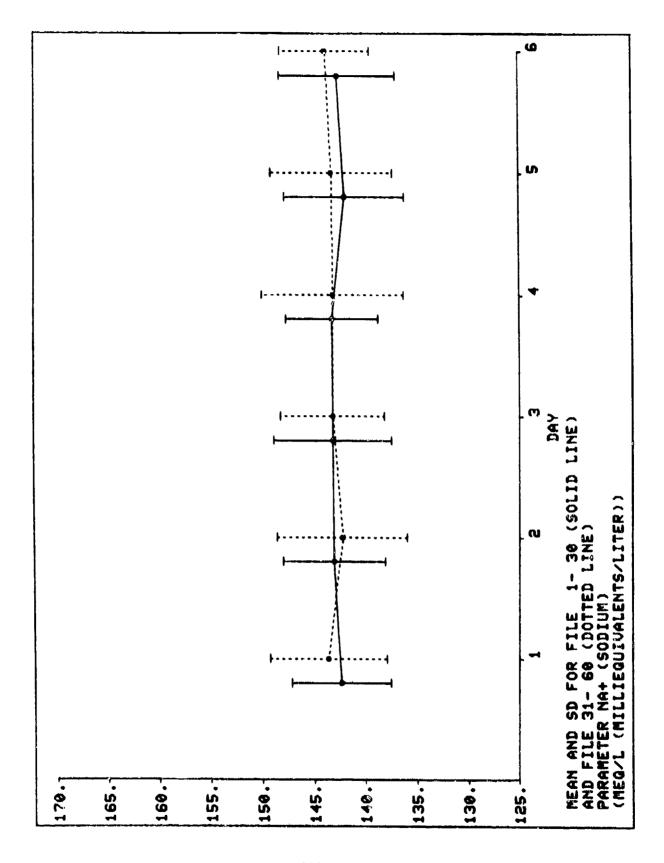
Elizabethan Koronia

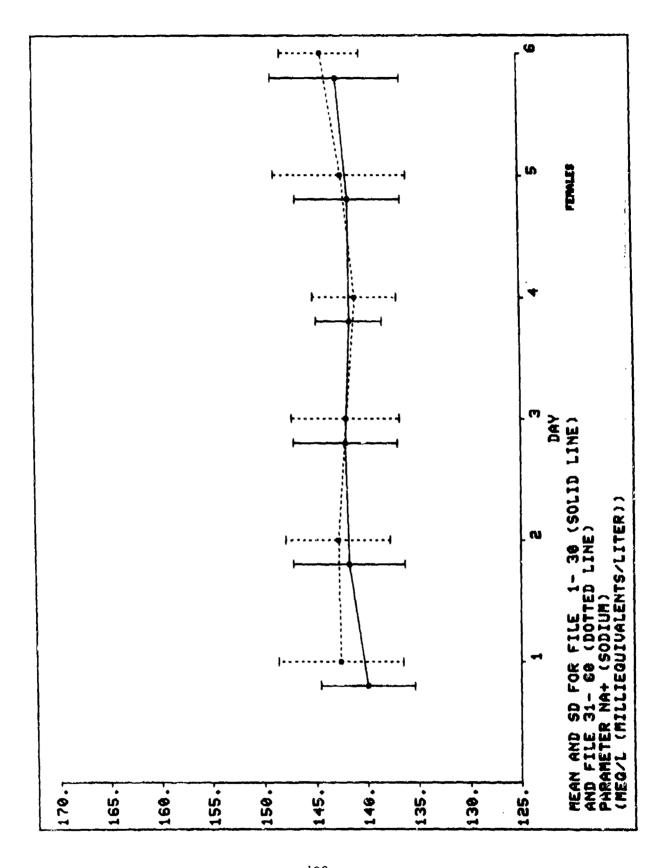


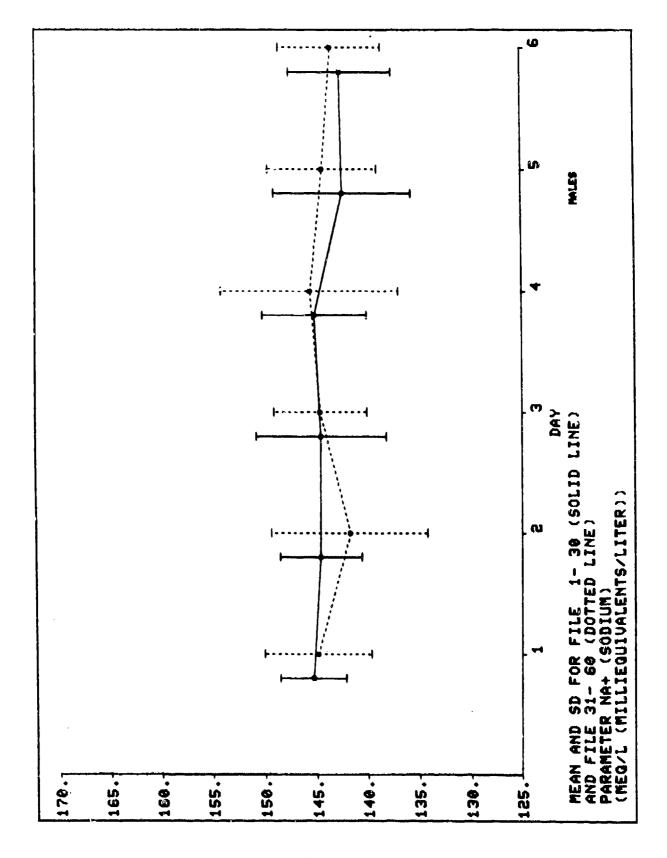


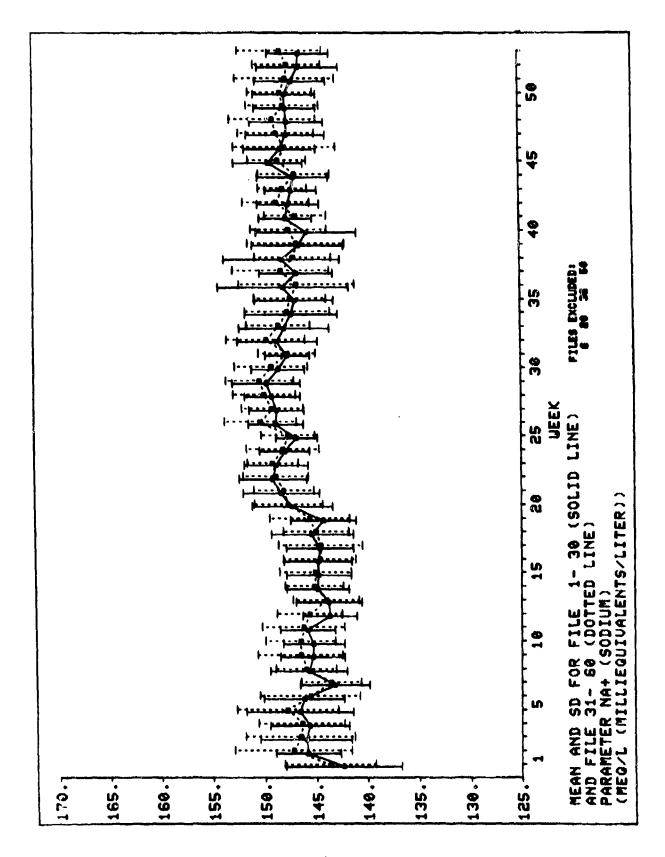
with an expension or man

The same of the same same series of the same series

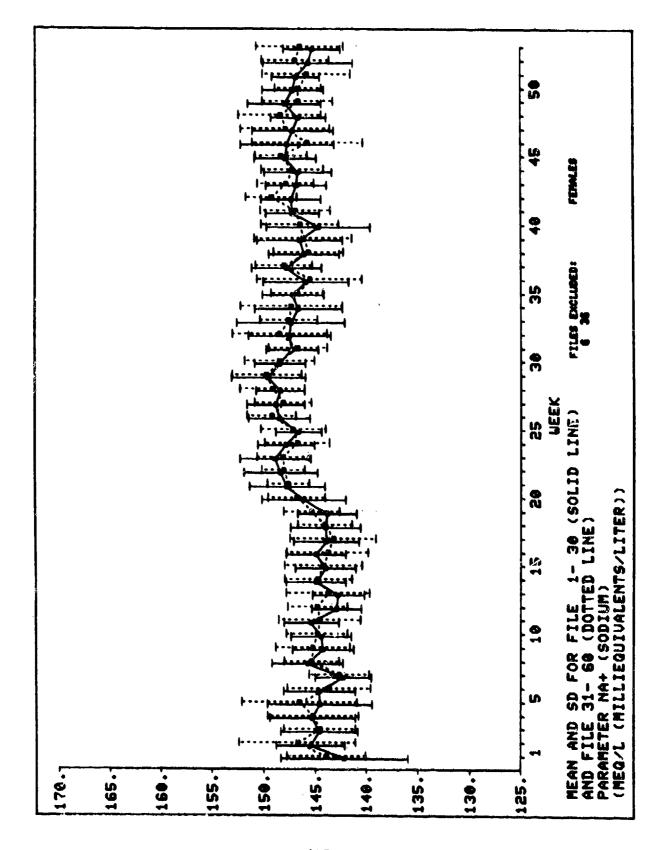


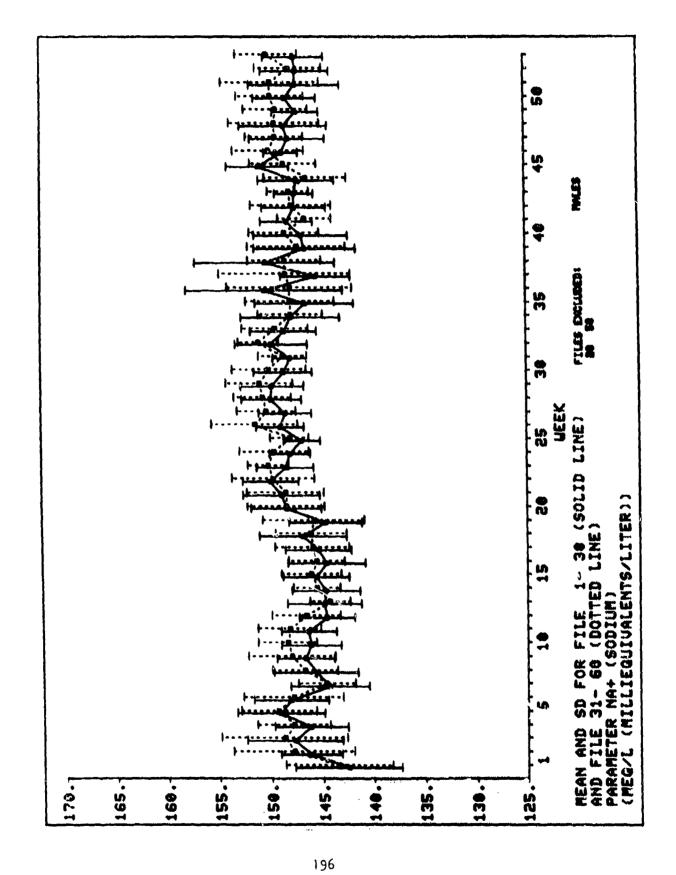


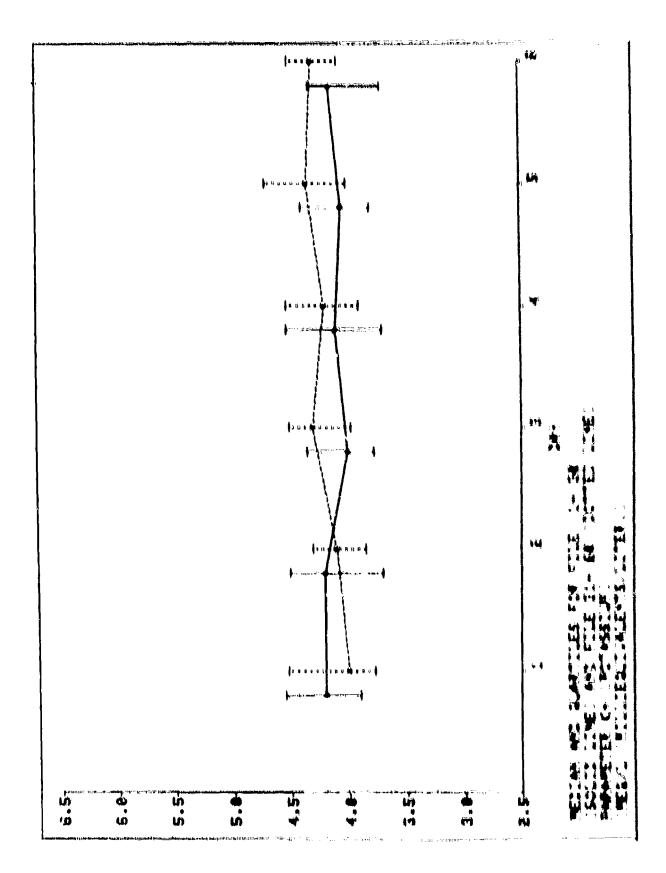


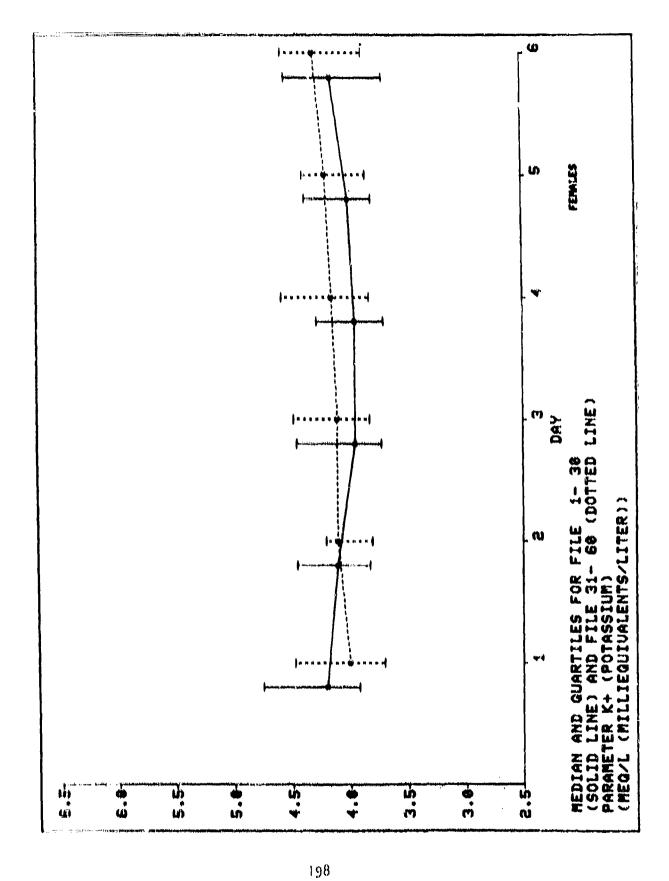


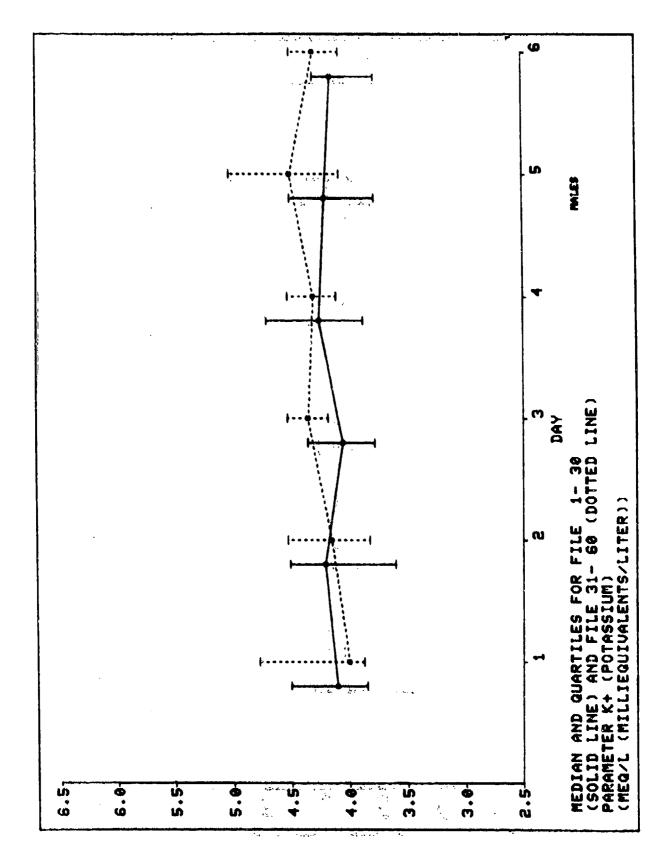
 $\mathcal{A}_{\mathcal{F}_{a,b}}^{(1)} \hookrightarrow \mathfrak{F}_{\mathcal{F}_{a}}^{(1)}$ 

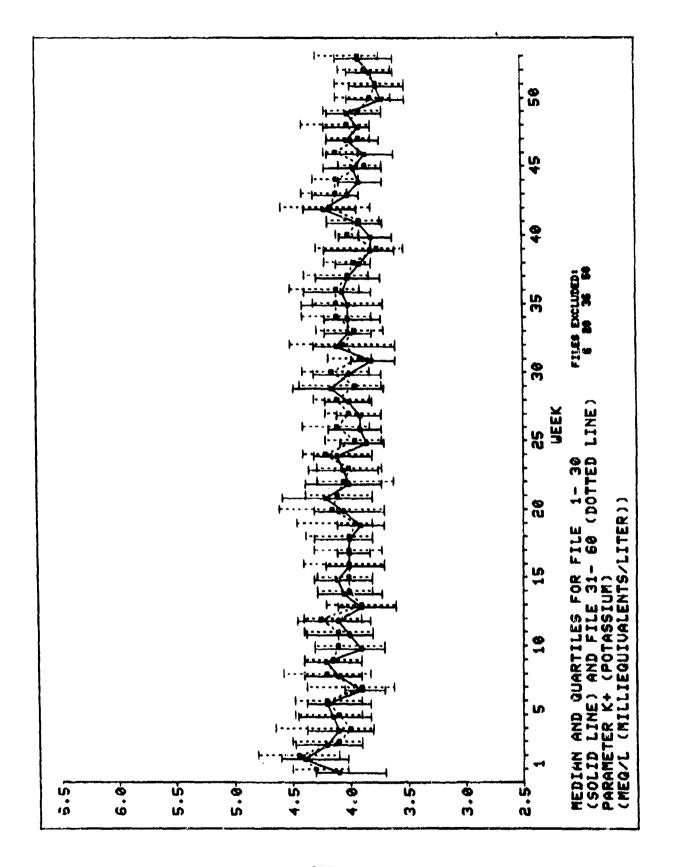


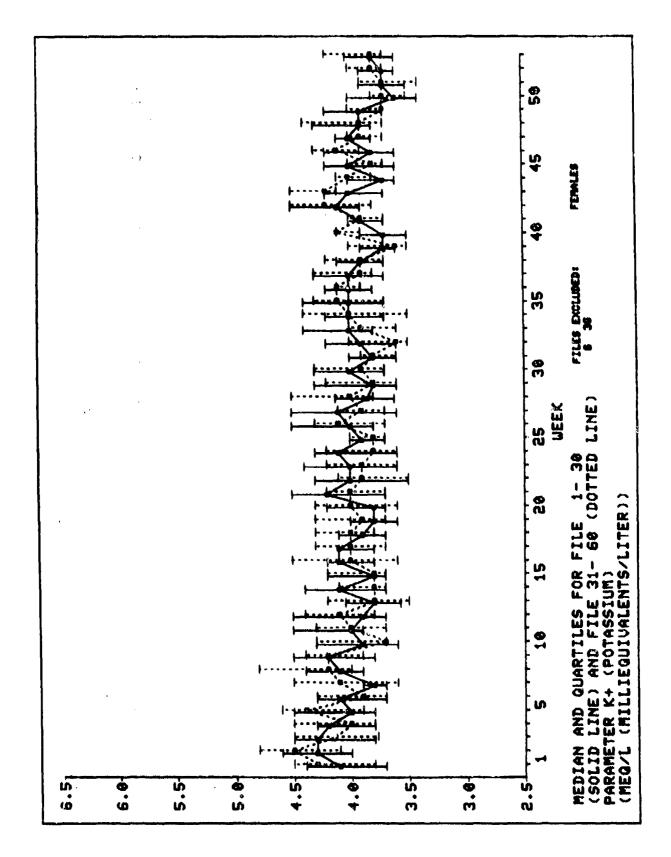


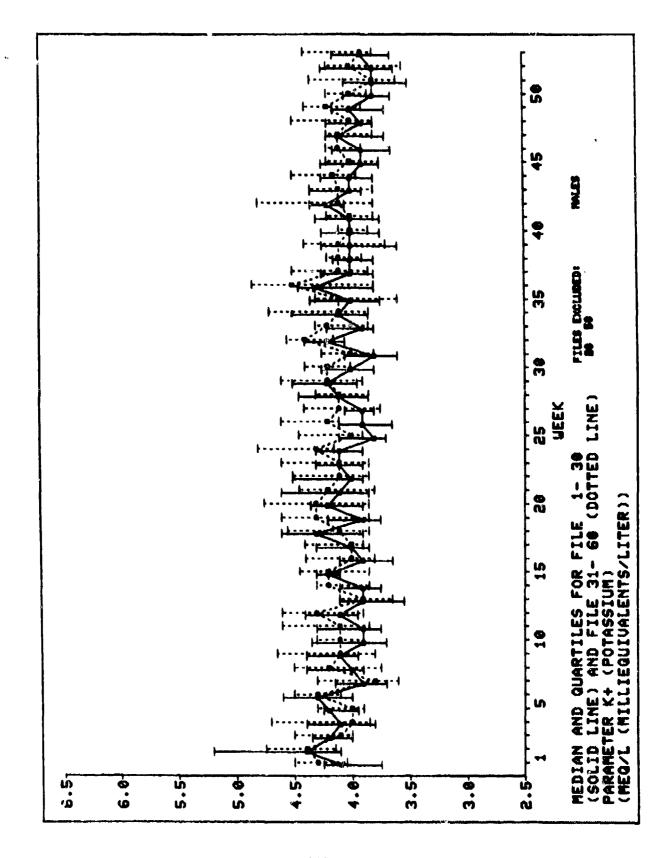


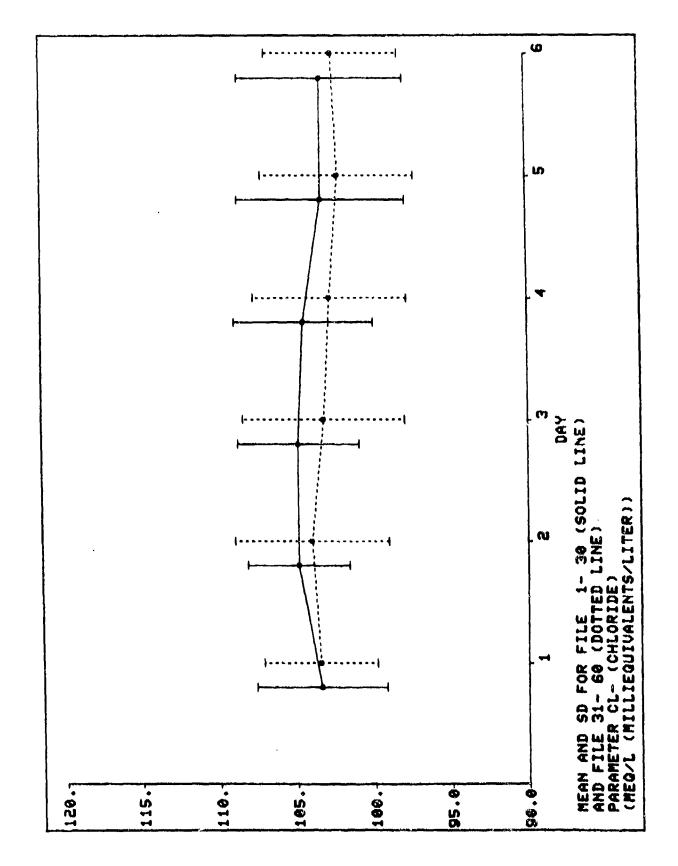


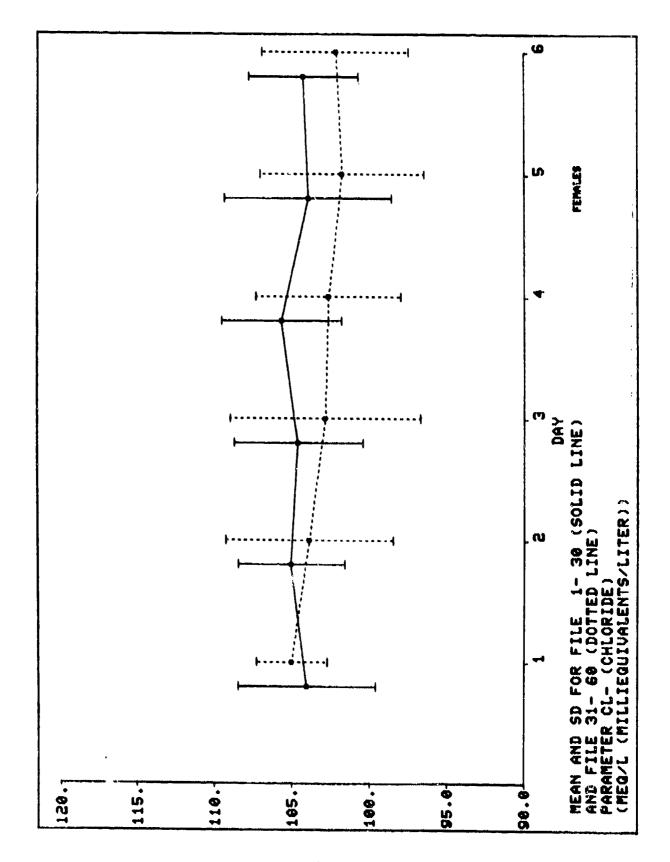




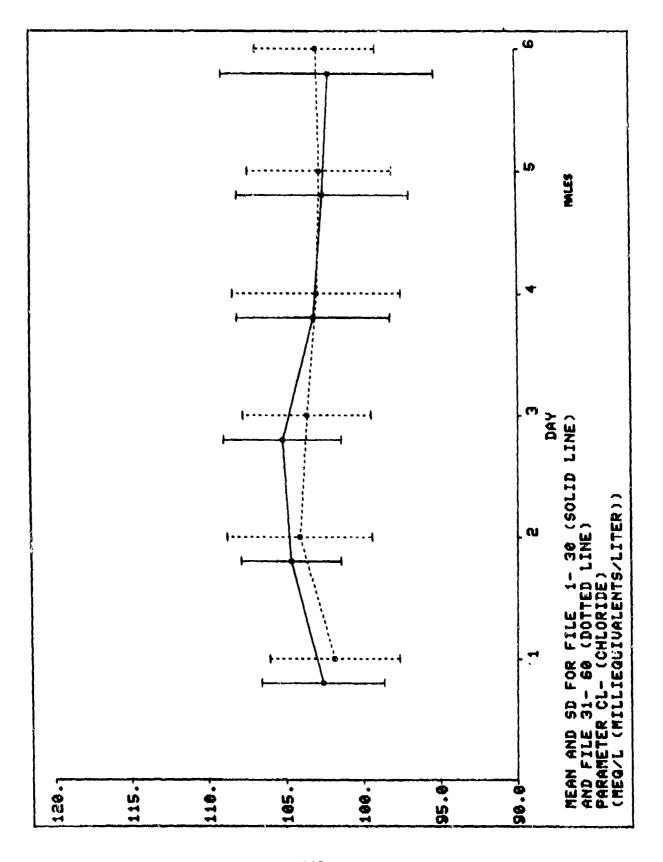


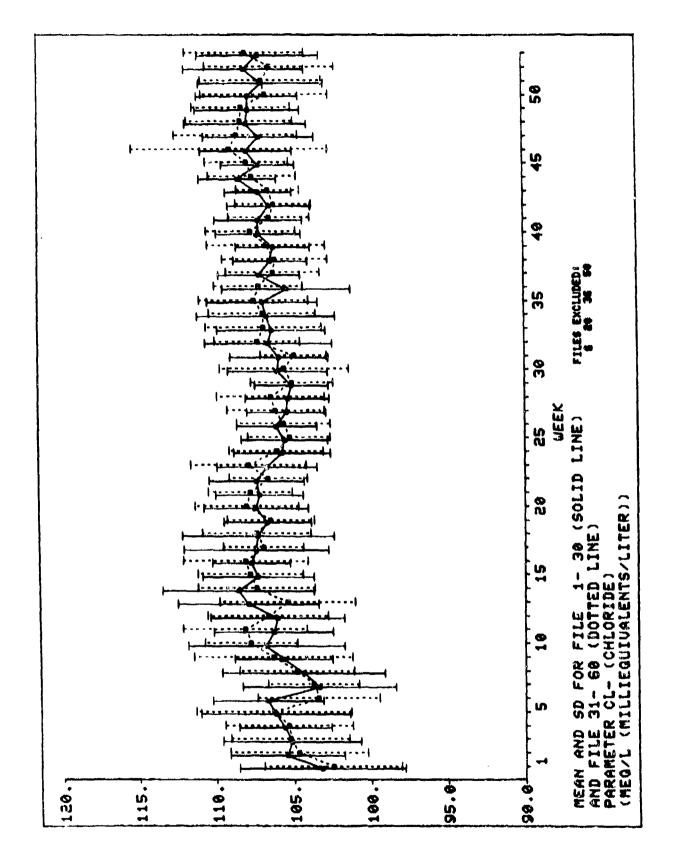


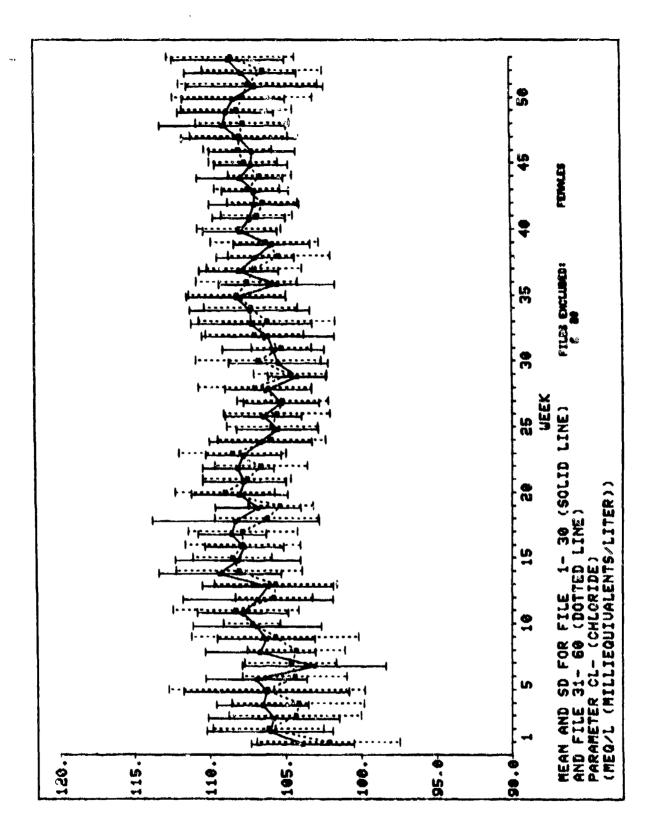




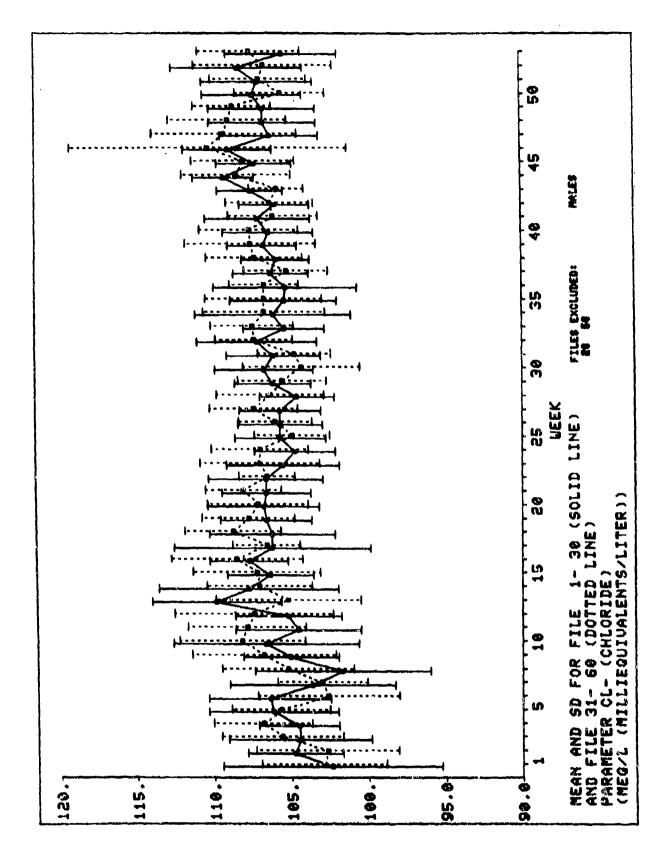
REAL MANAGER

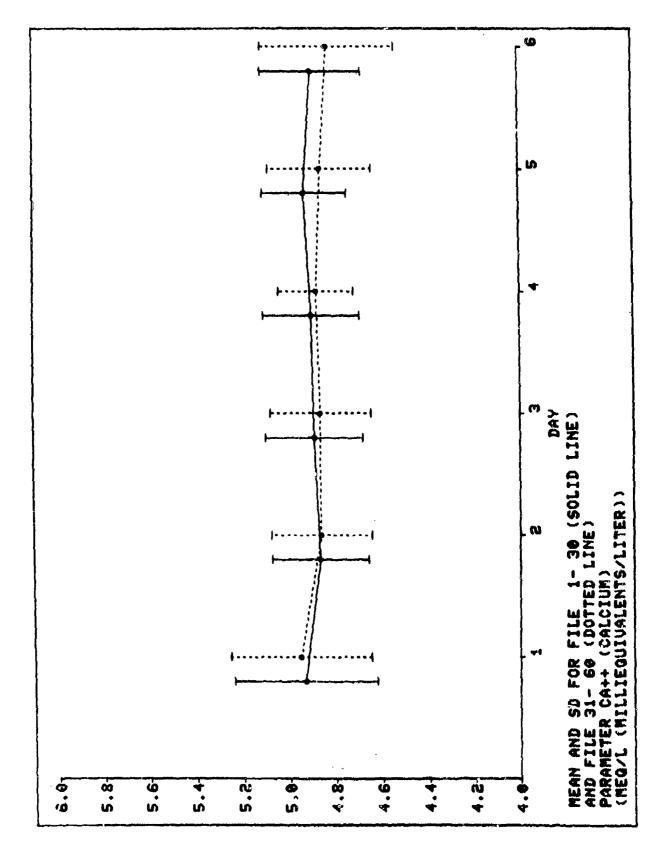


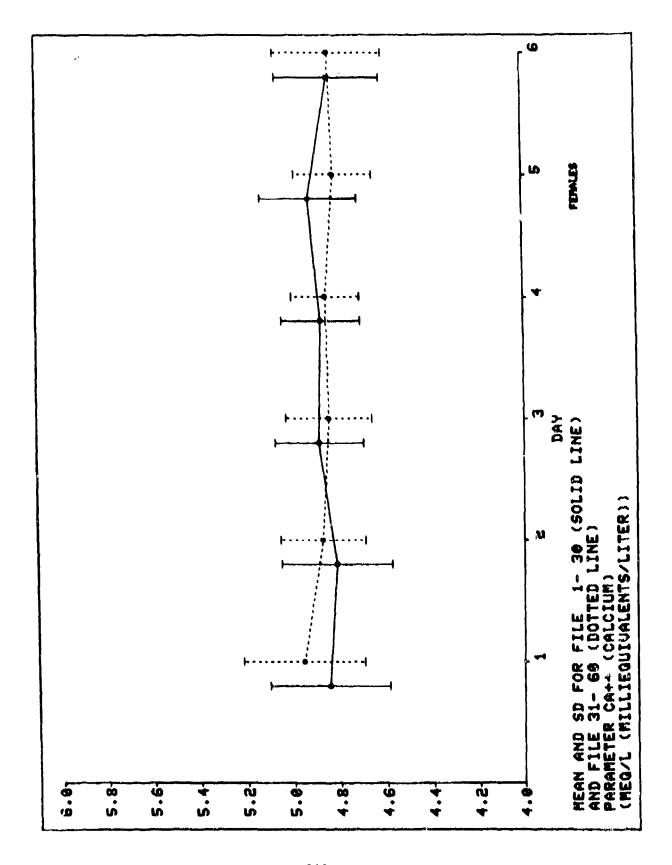


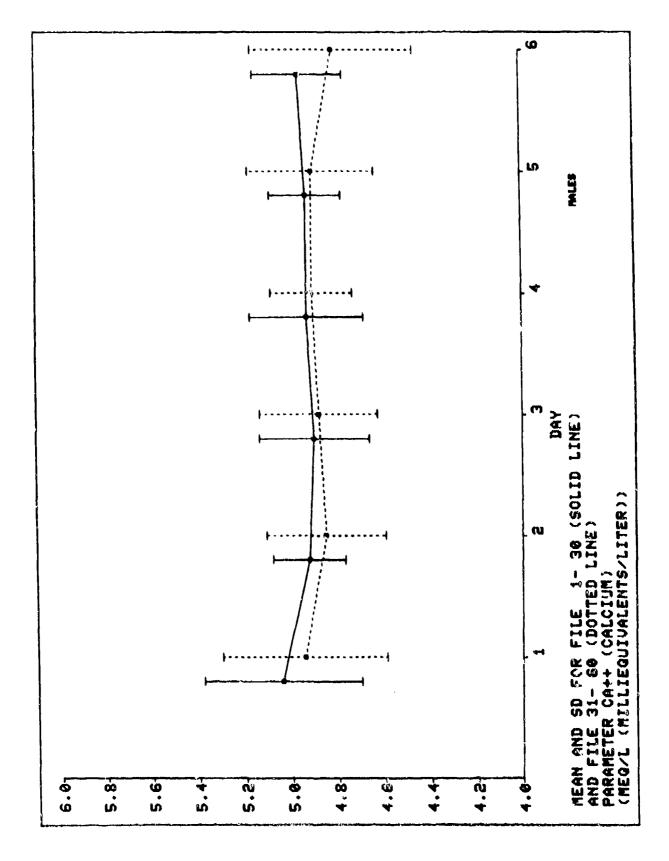


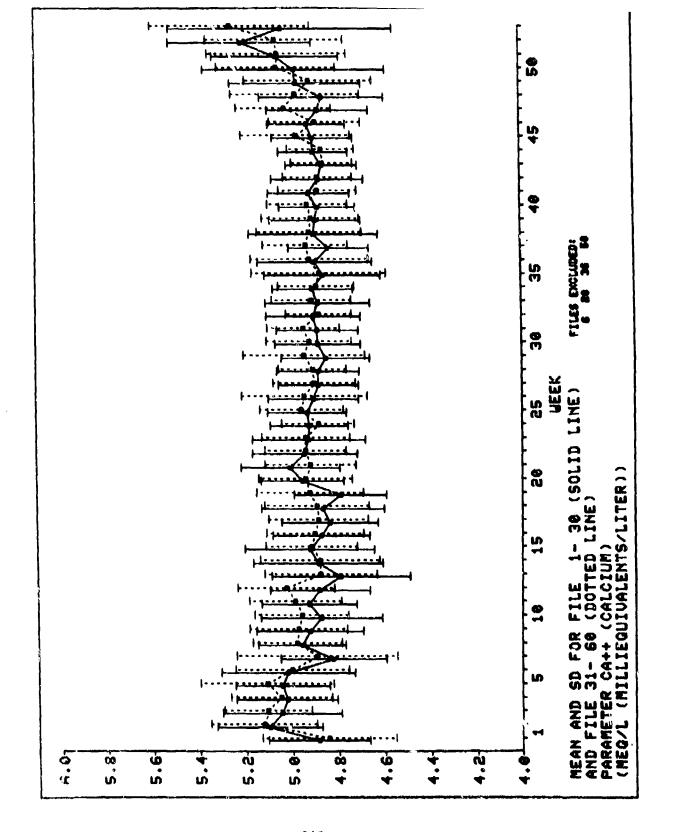
The company of the control of the co

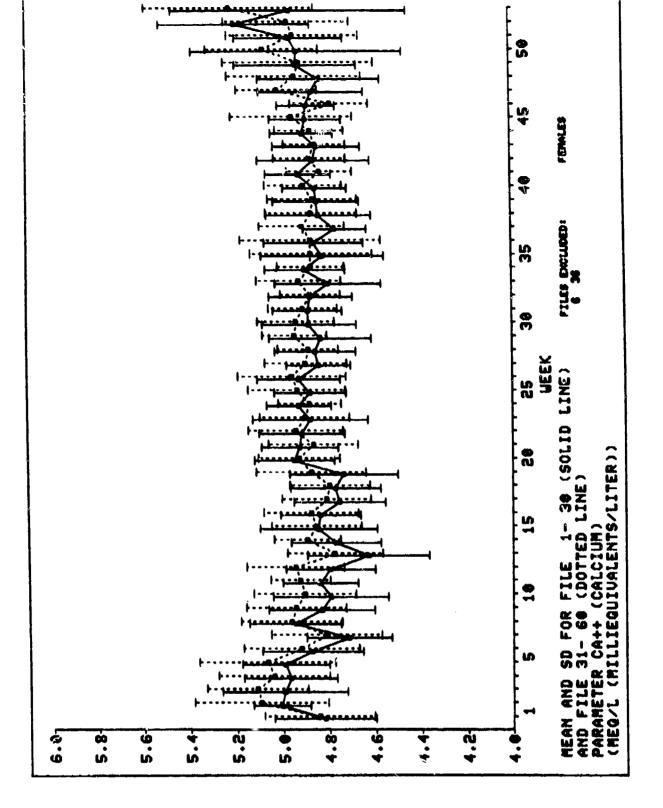


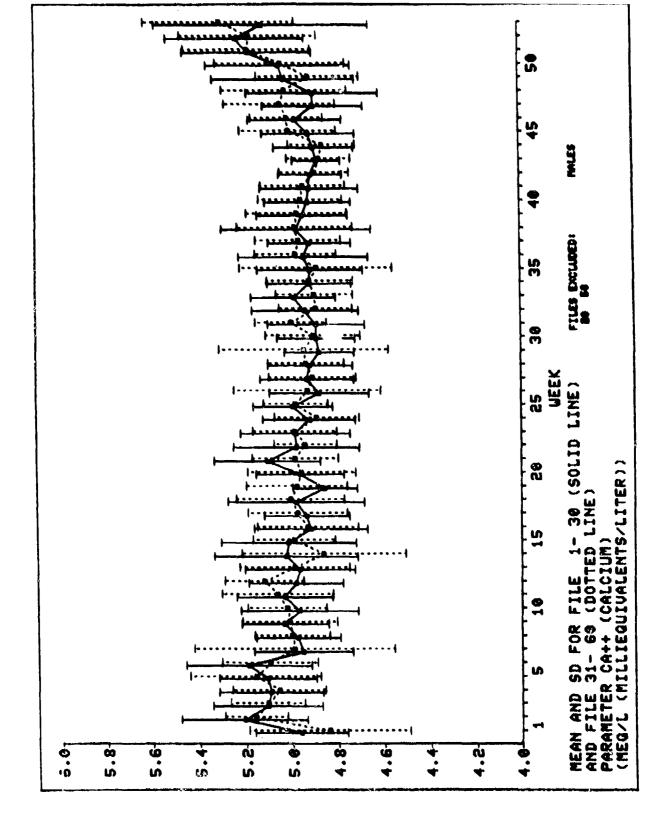


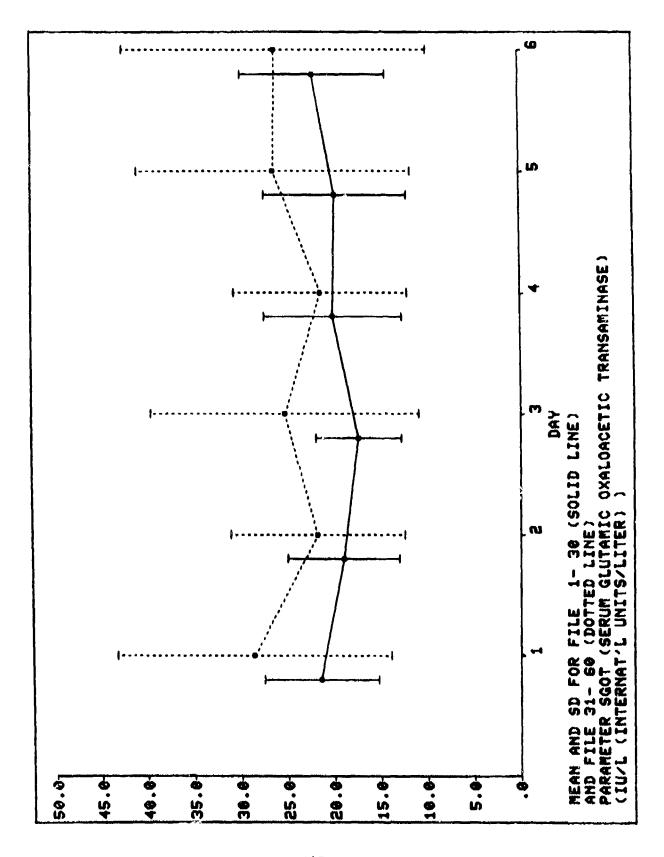


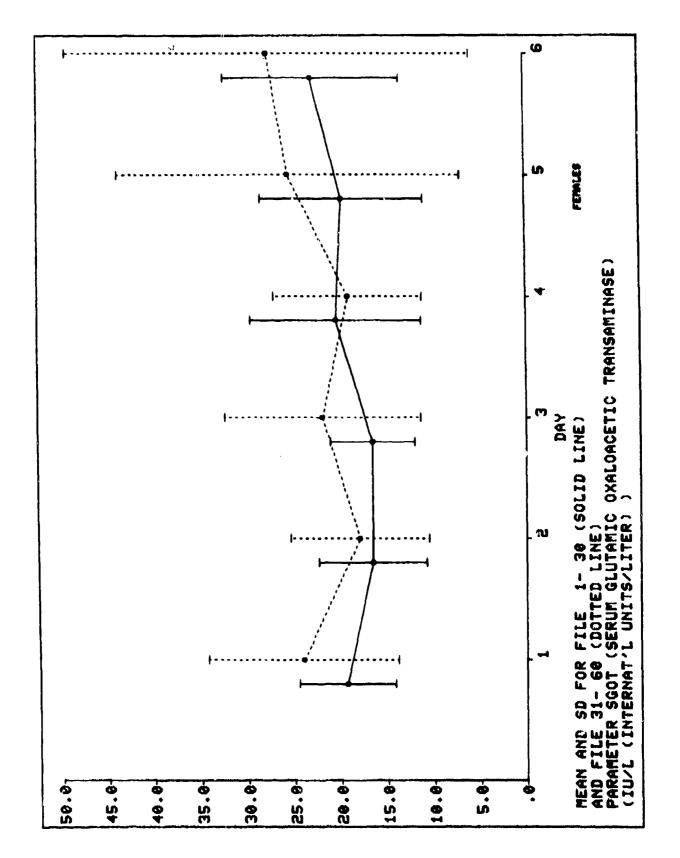




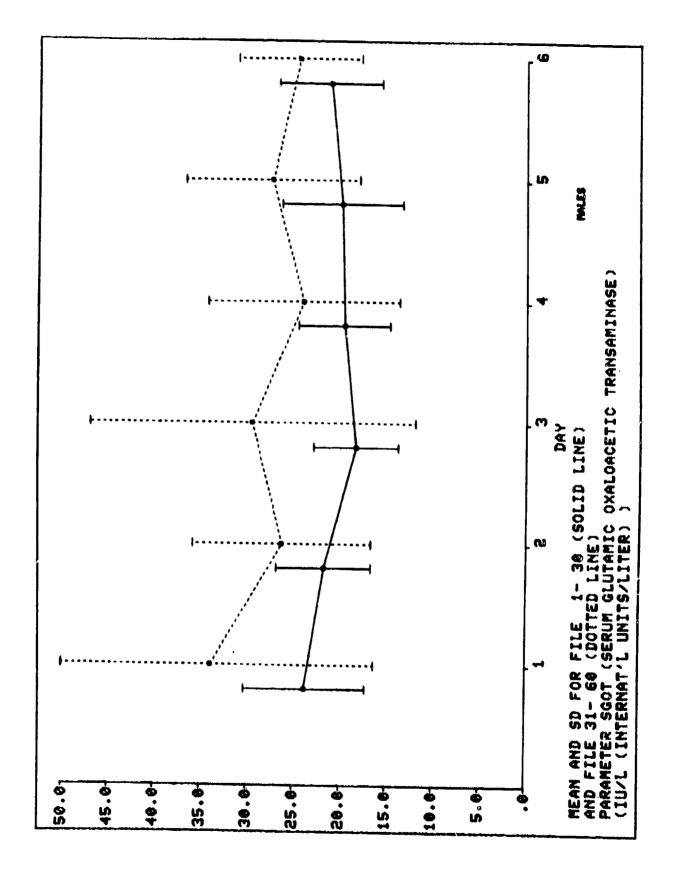


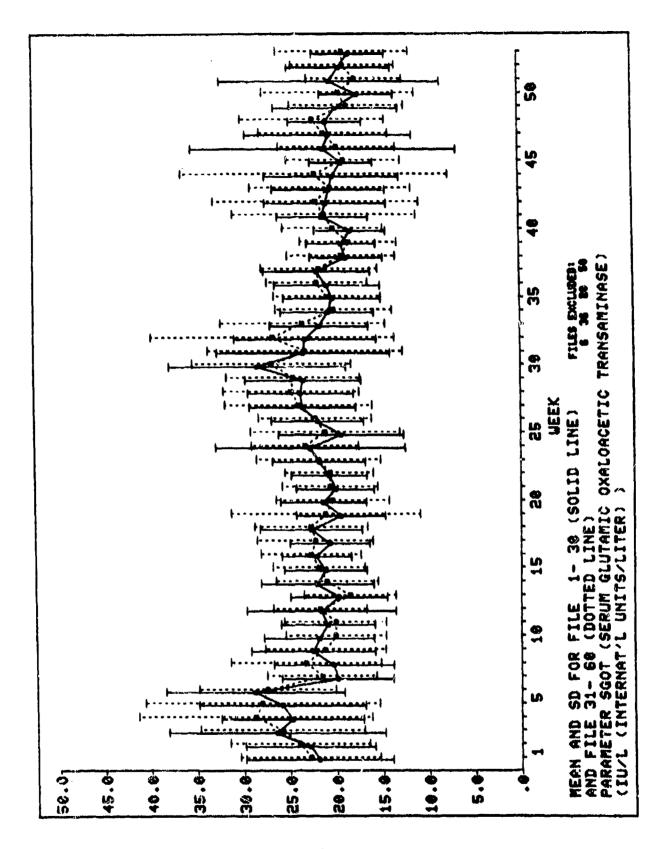


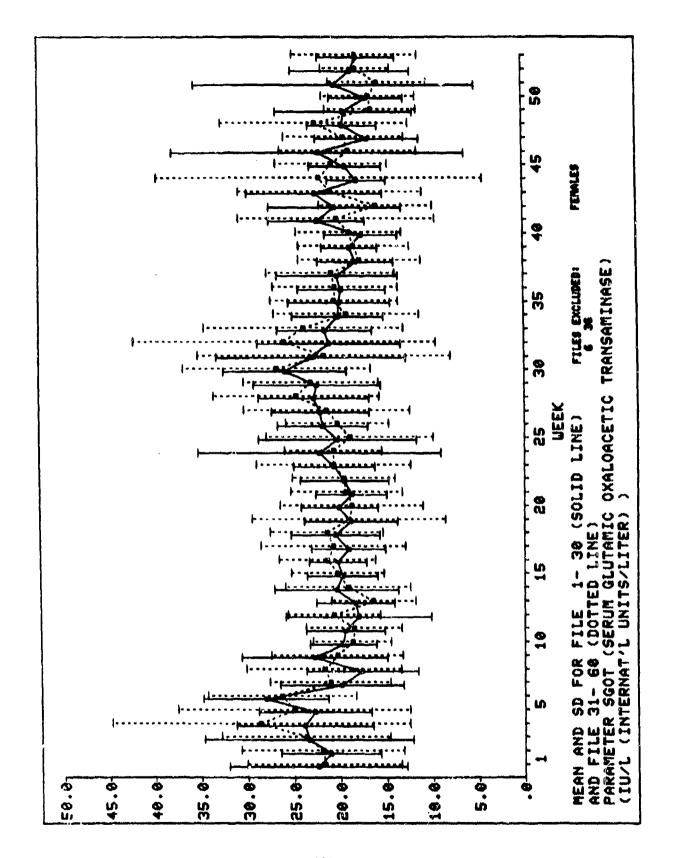




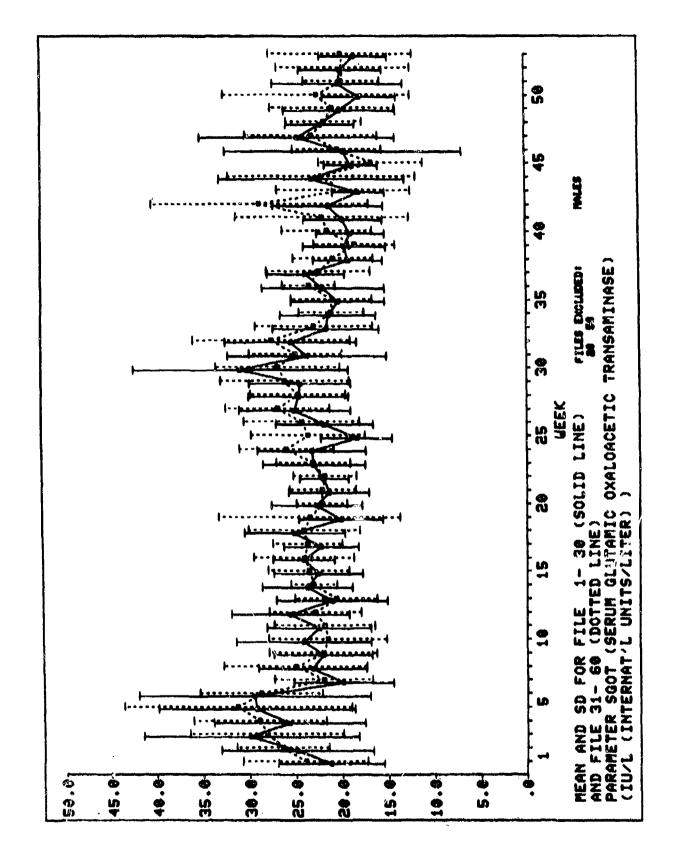
でものは特別の確認



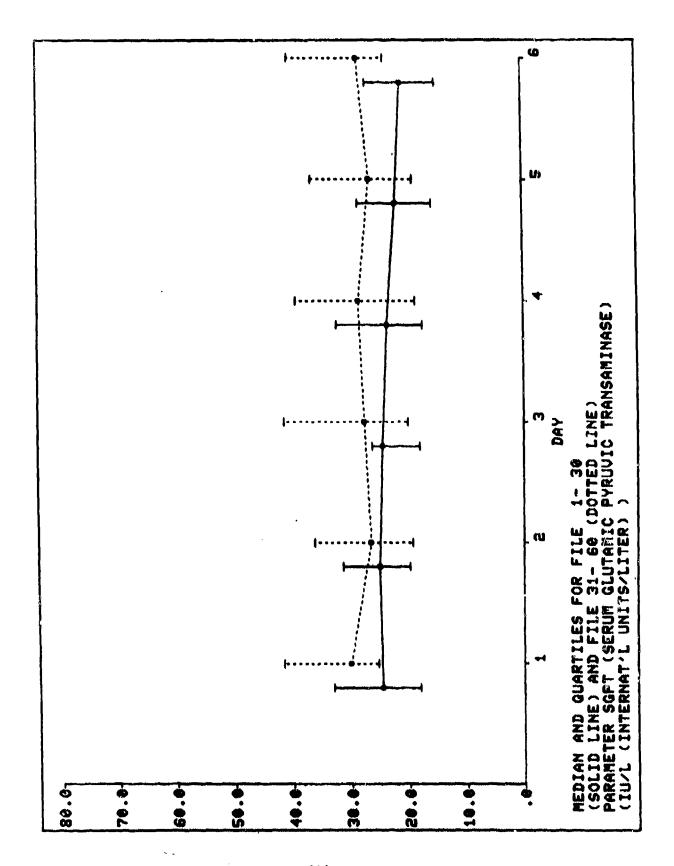


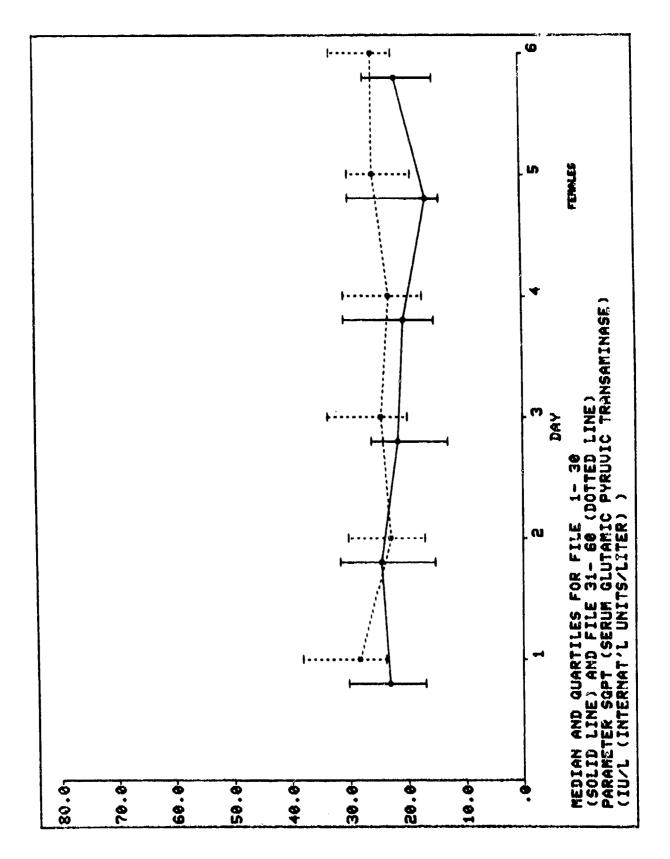


The same of the sa

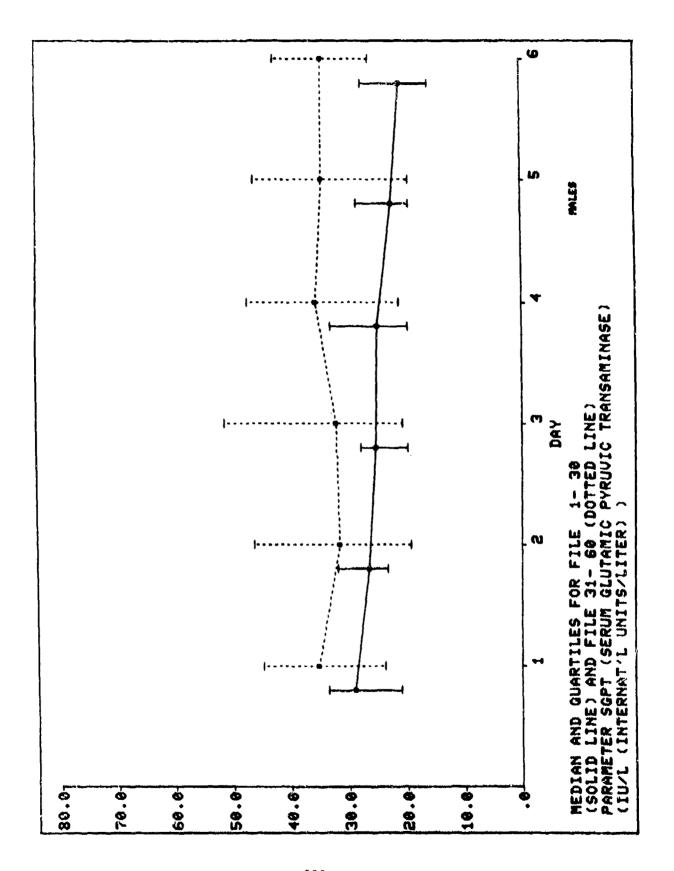


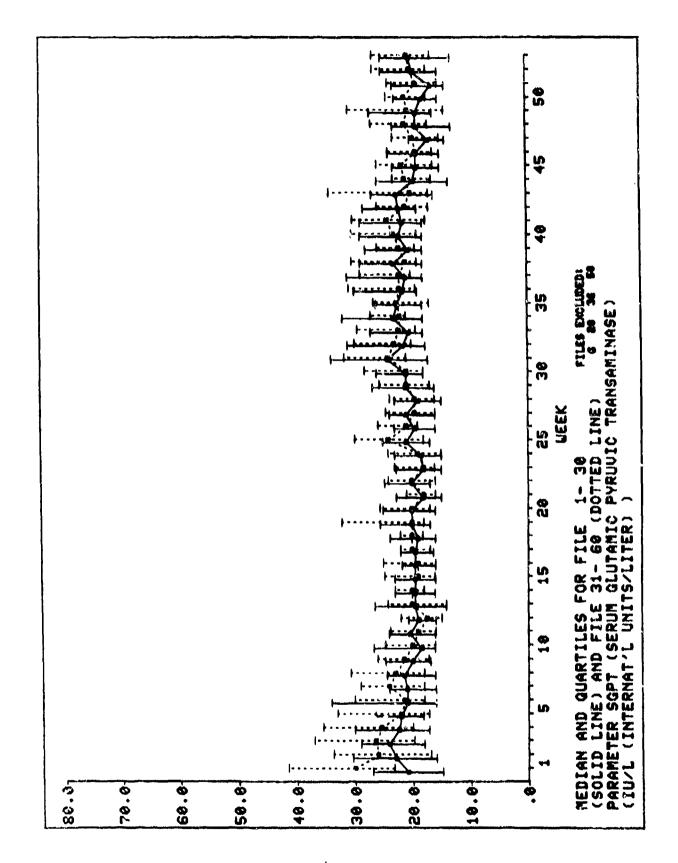
 $\mathbb{E}[q_{n}^{\mathrm{opt}}, q_{n}^{\mathrm{opt}}] \leq \frac{n \lambda}{2} q_{n}^{\mathrm{opt}}, q_{n}^{\mathrm{opt}}, q_{n}^{\mathrm{opt}}, q_{n}^{\mathrm{opt}}]$ 

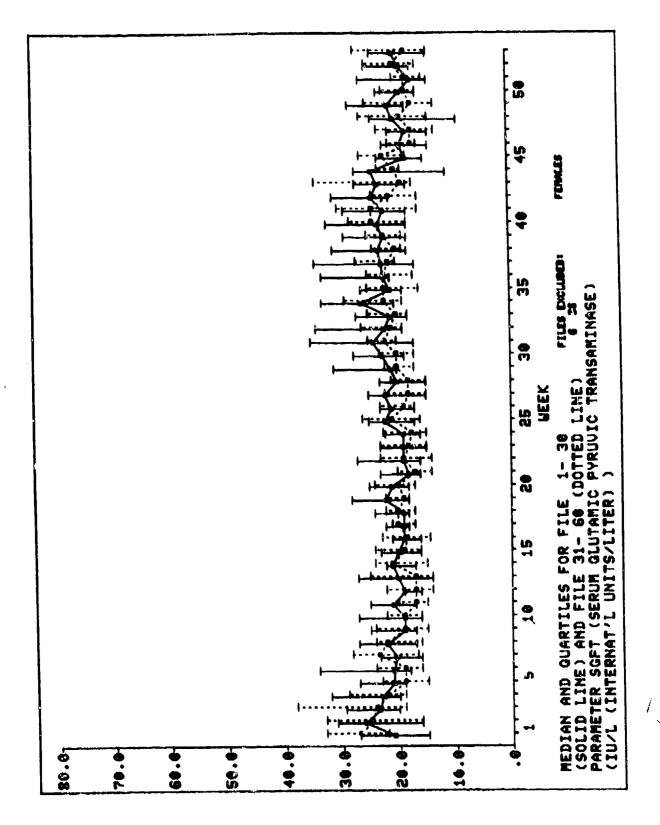


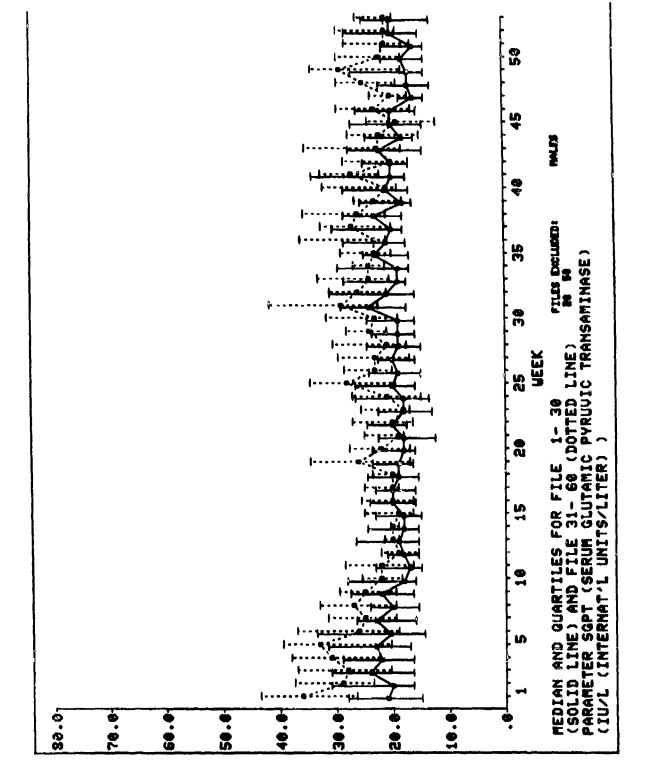


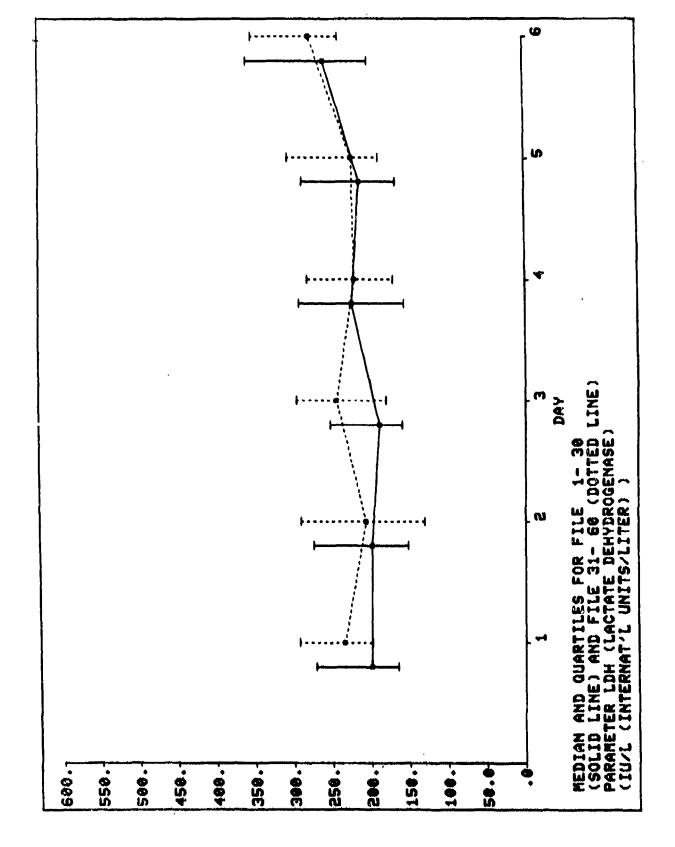
 $\hat{q}(\mathcal{M}) \in \mathcal{M}(\mathbb{R}^n)$ 

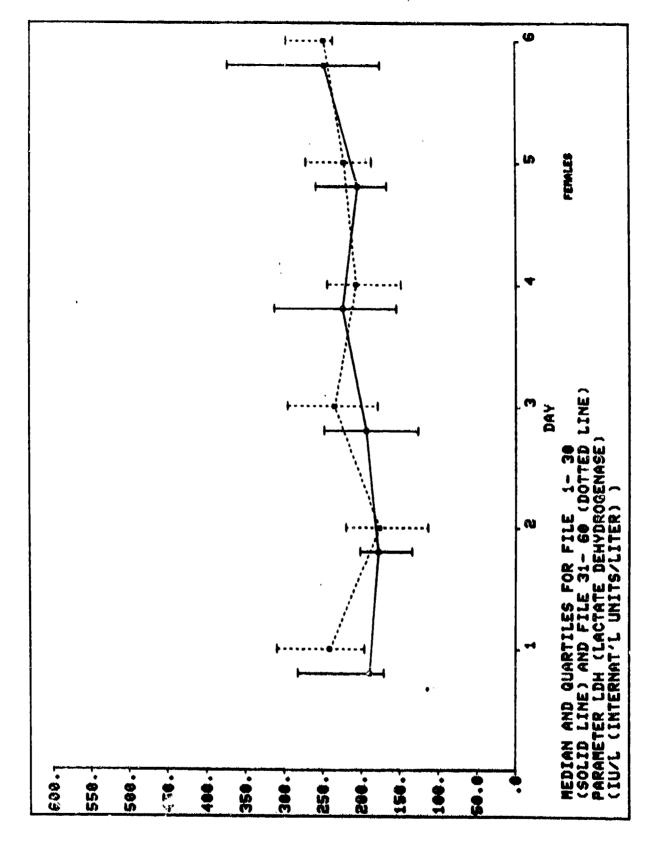




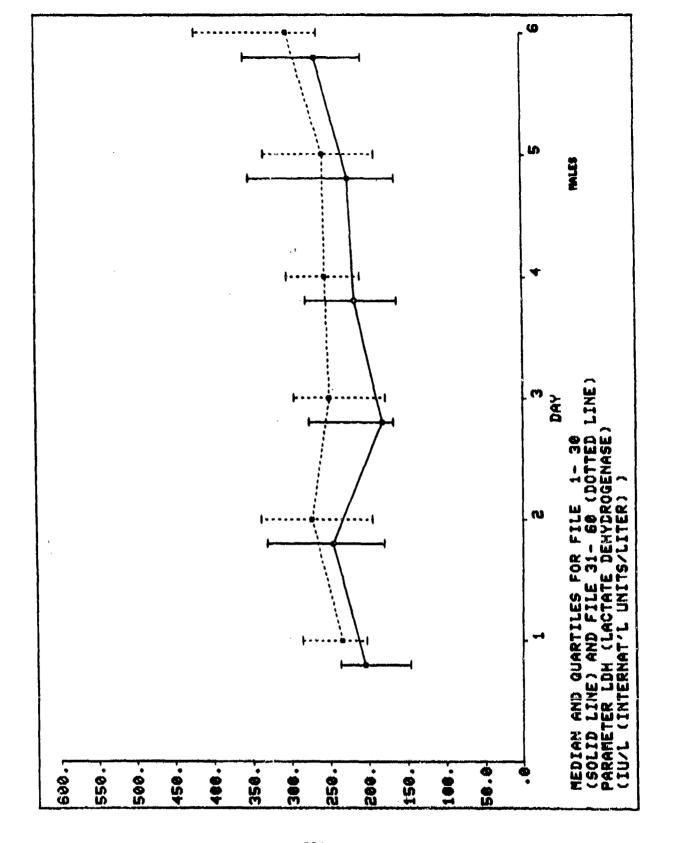


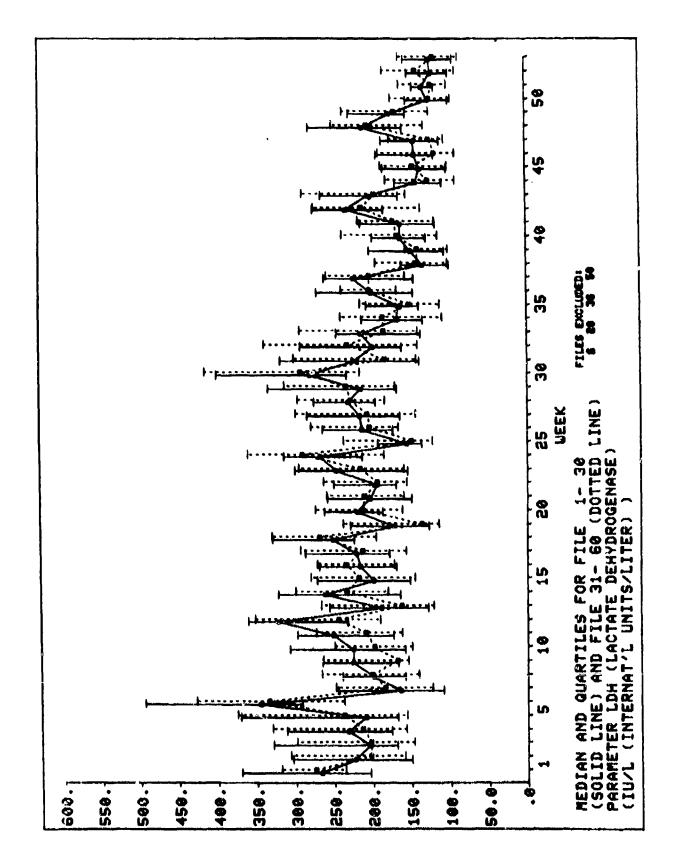




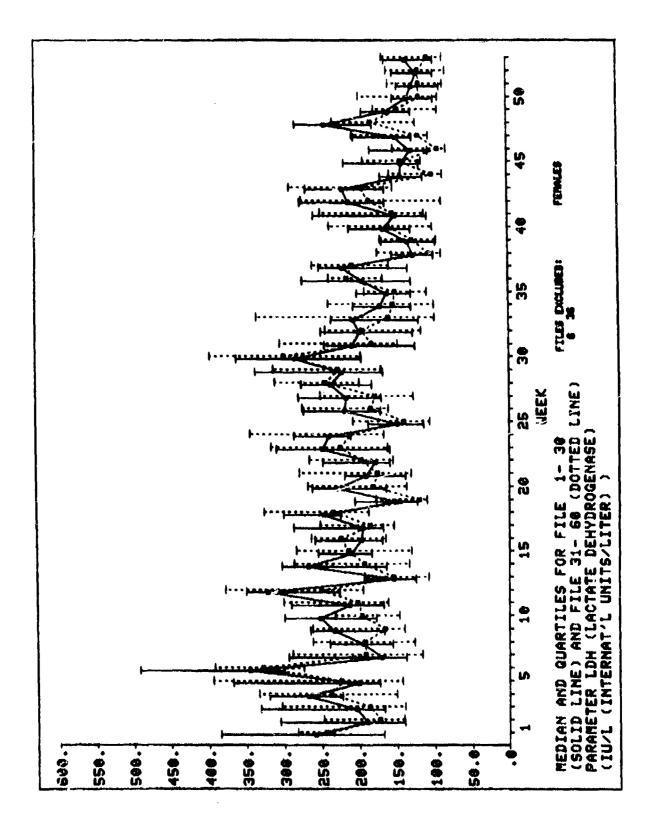


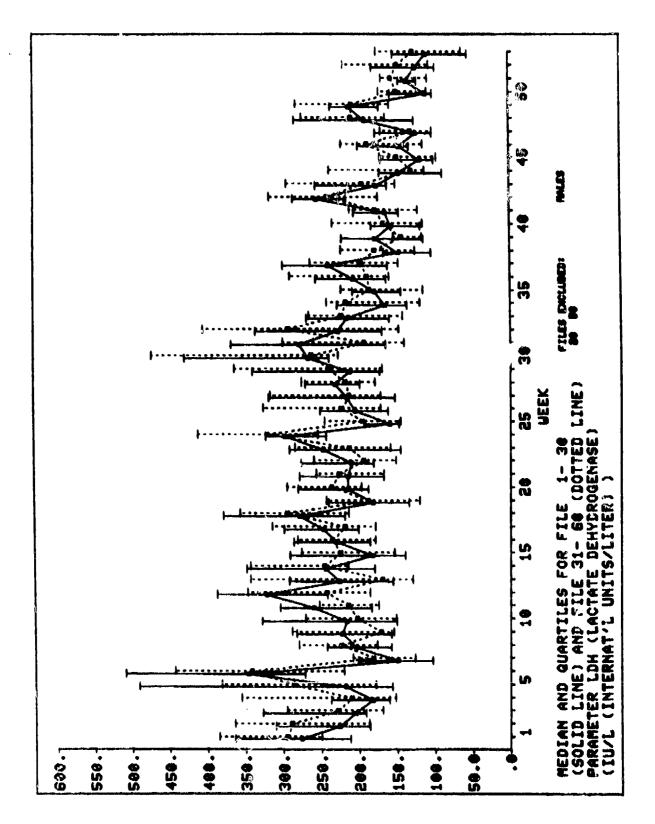
Same Same

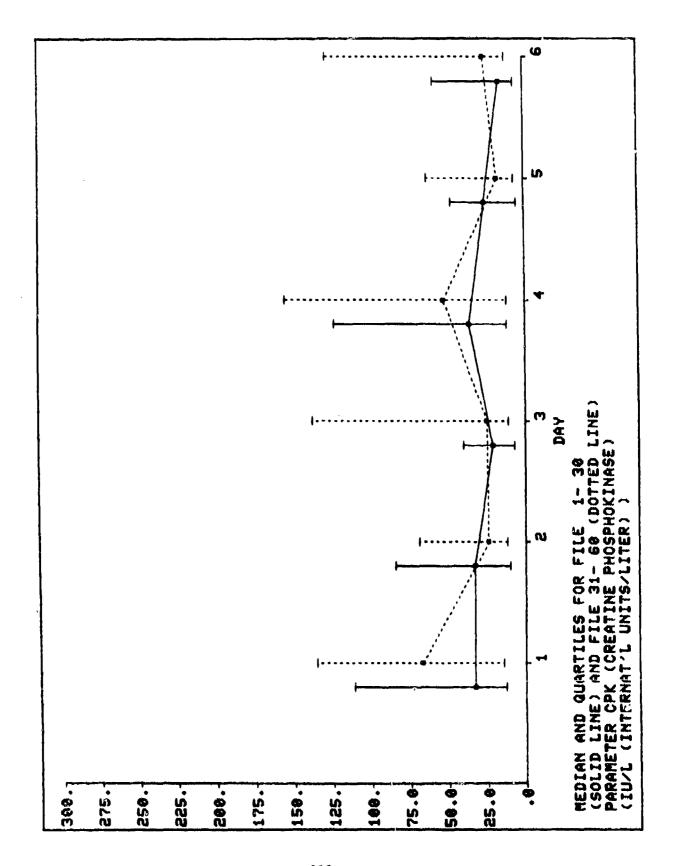


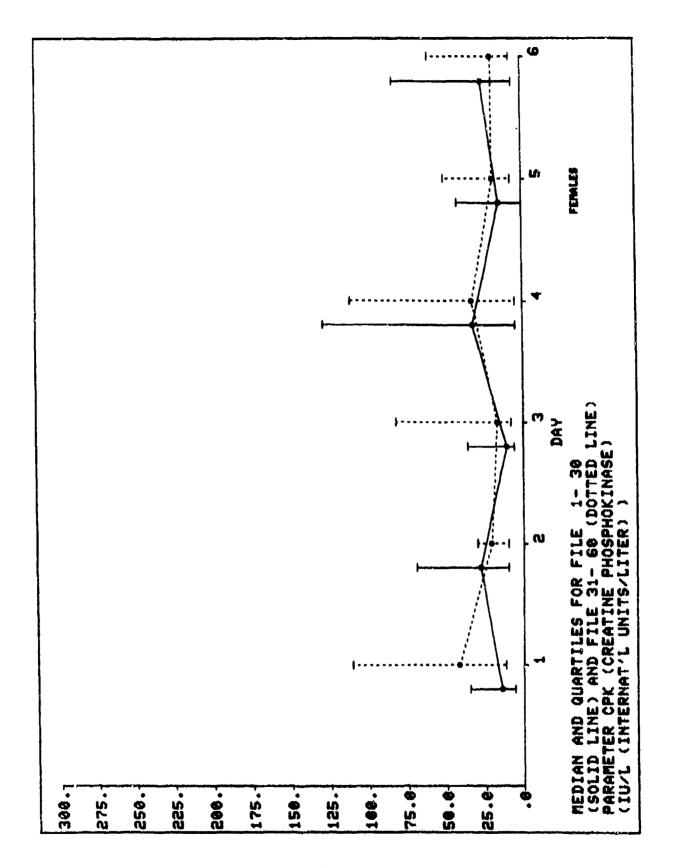


 $\mathcal{W}_{\mathrm{position}}(\mathcal{W},\mathcal{W}_{\mathrm{position}}) = \mathcal{W}_{\mathrm{position}}(\mathcal{W},\mathcal{W}_{\mathrm{position}}) = \mathcal{W}_{\mathrm{position}}(\mathcal{W},\mathcal{W}_{\mathrm{position}})$ 





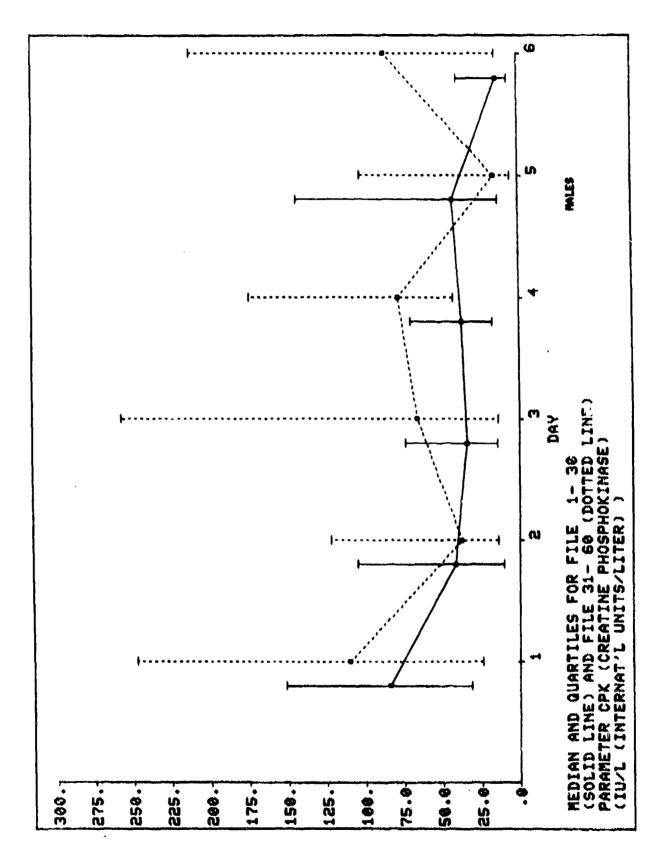


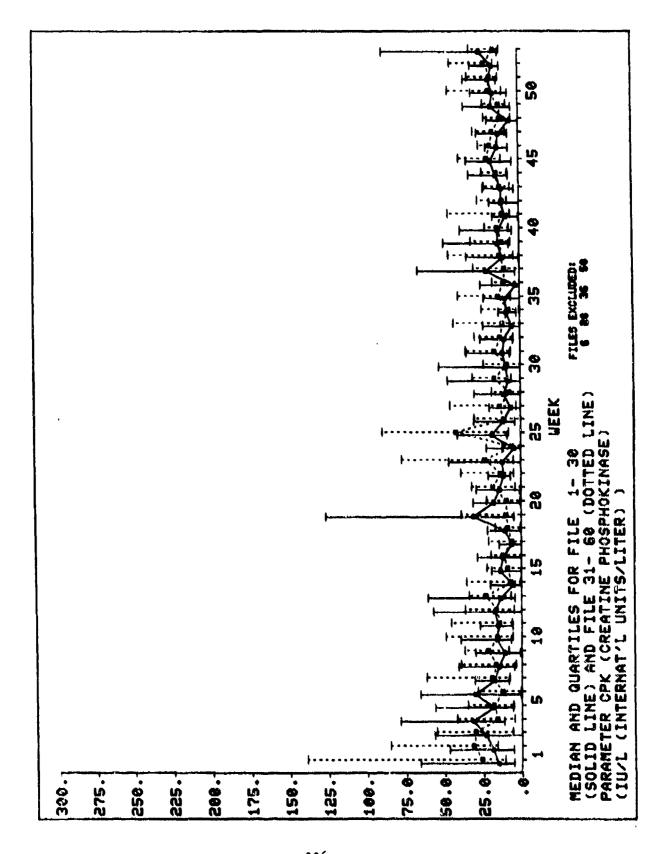


Andrew Comment of the Comment of the

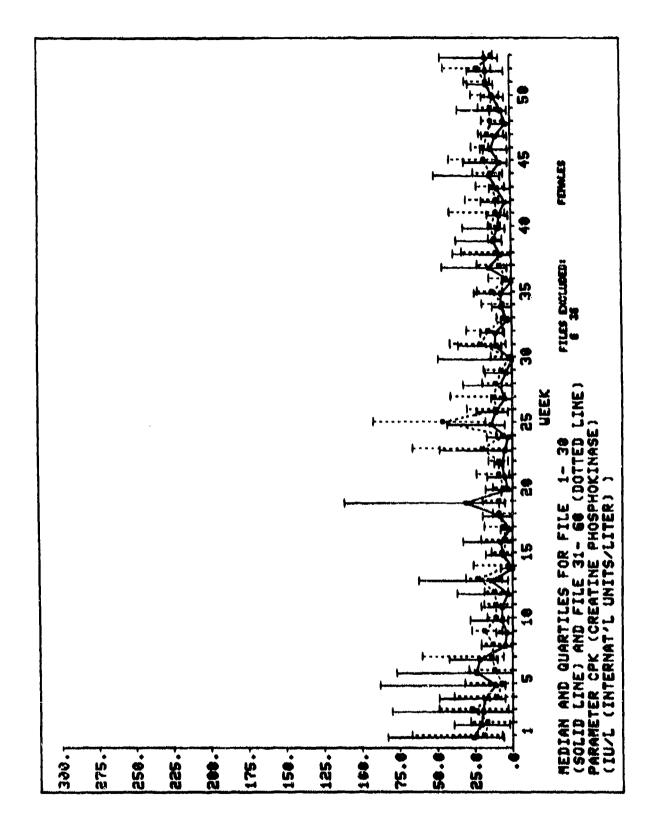
AND THE PROPERTY OF THE PROPER

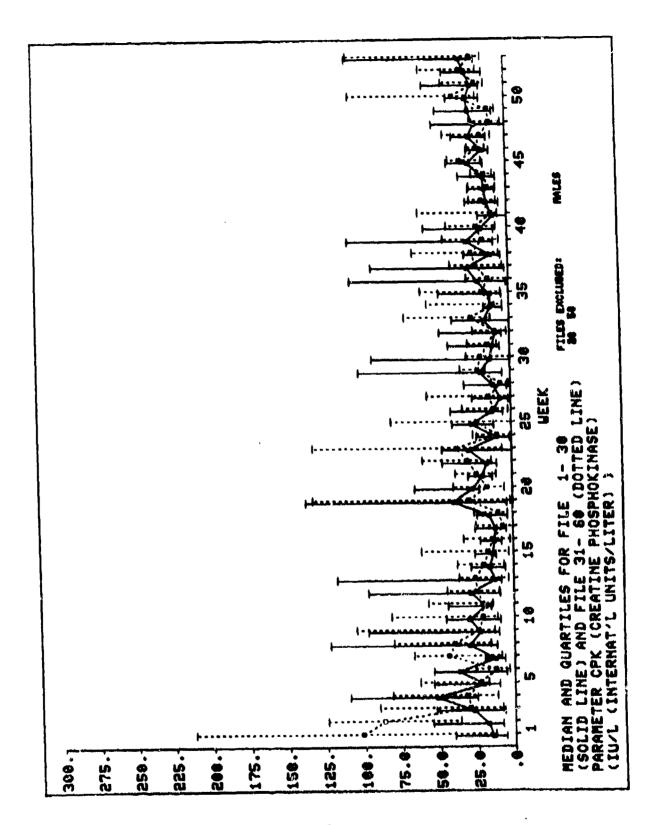
**まるの機能的に関する** 

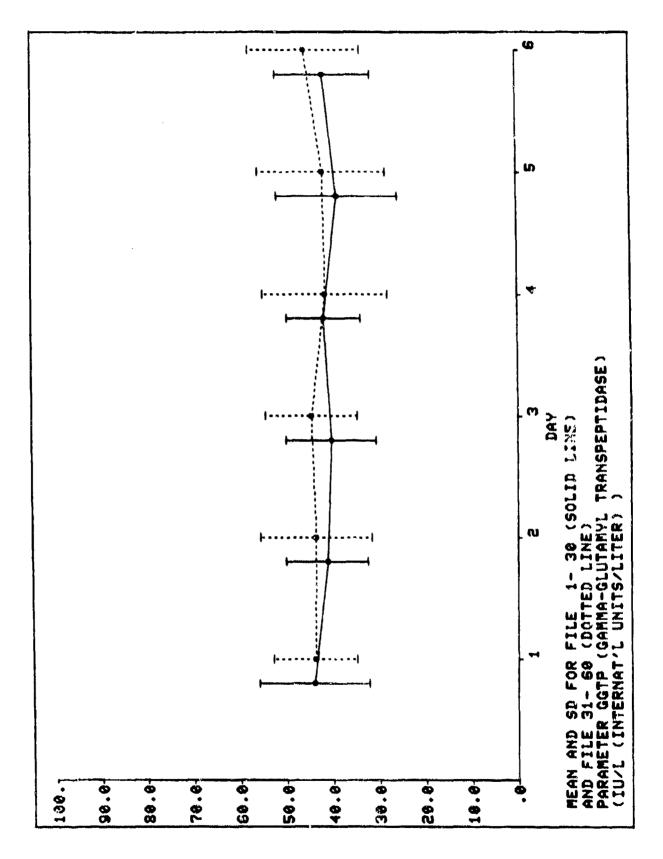


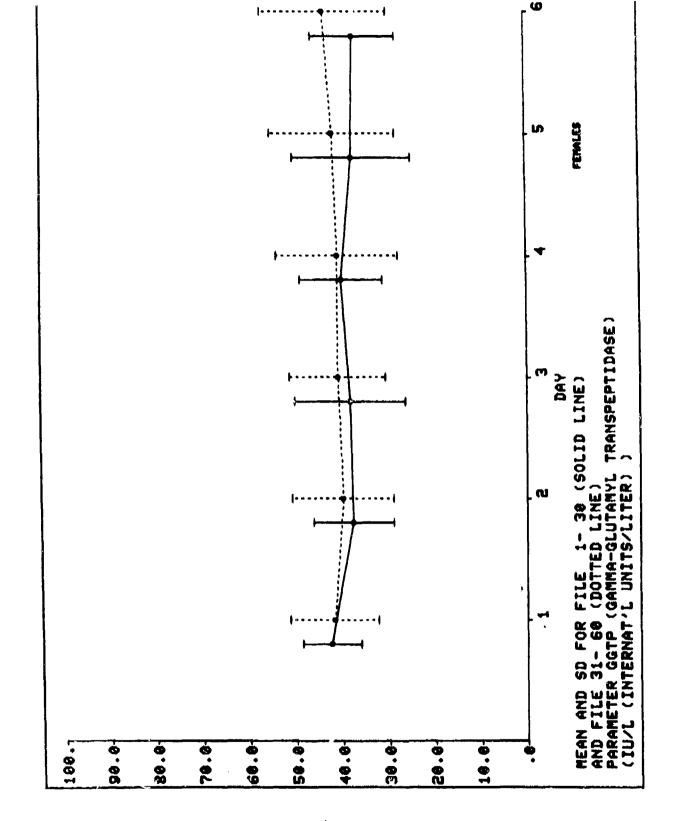


State of the second



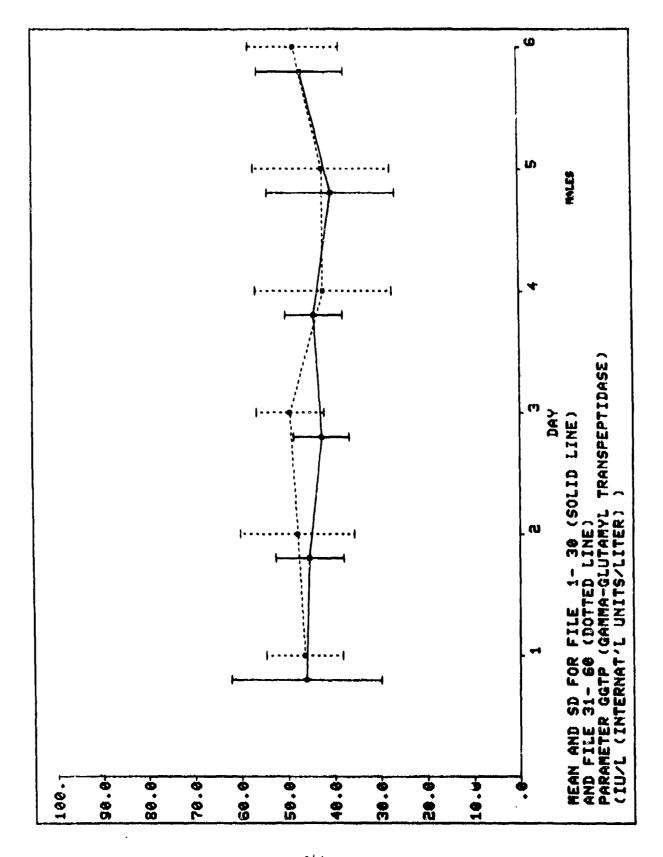


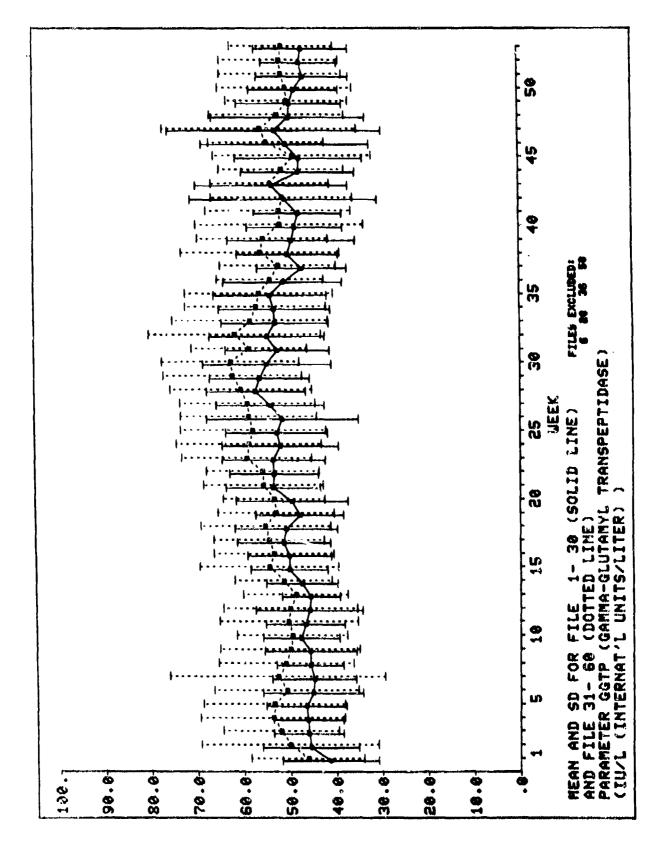


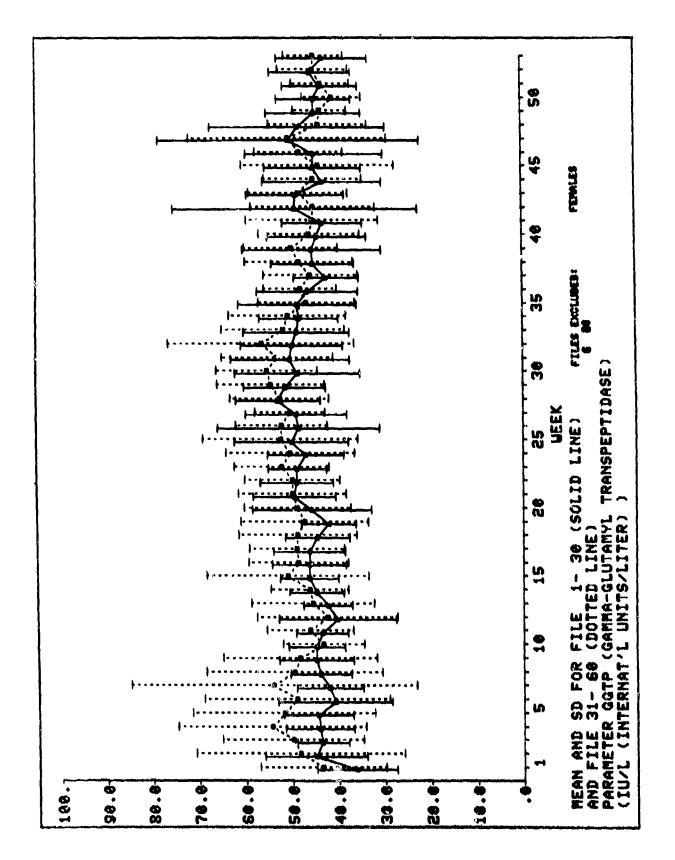


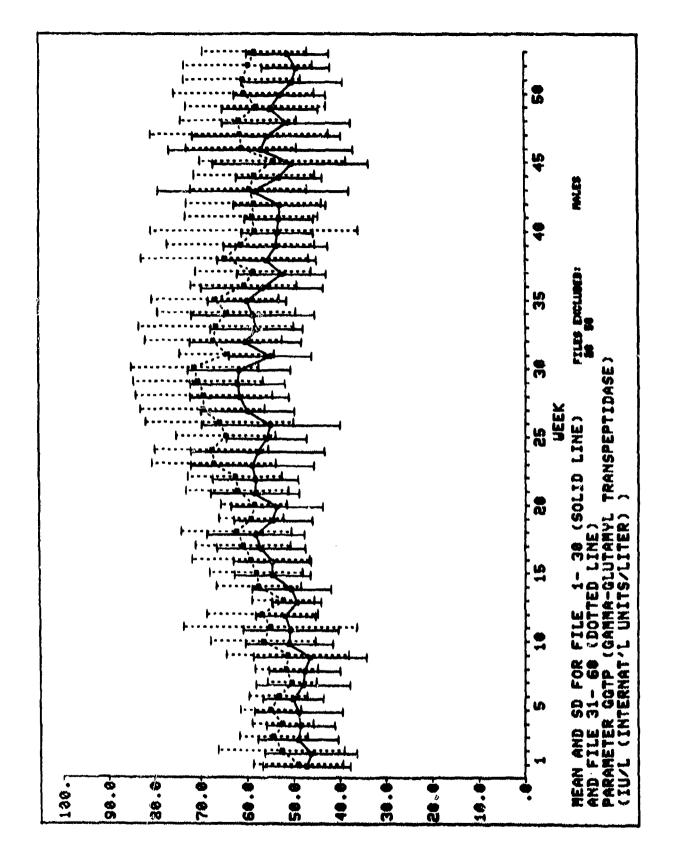
The state of the s

1. 在實施影

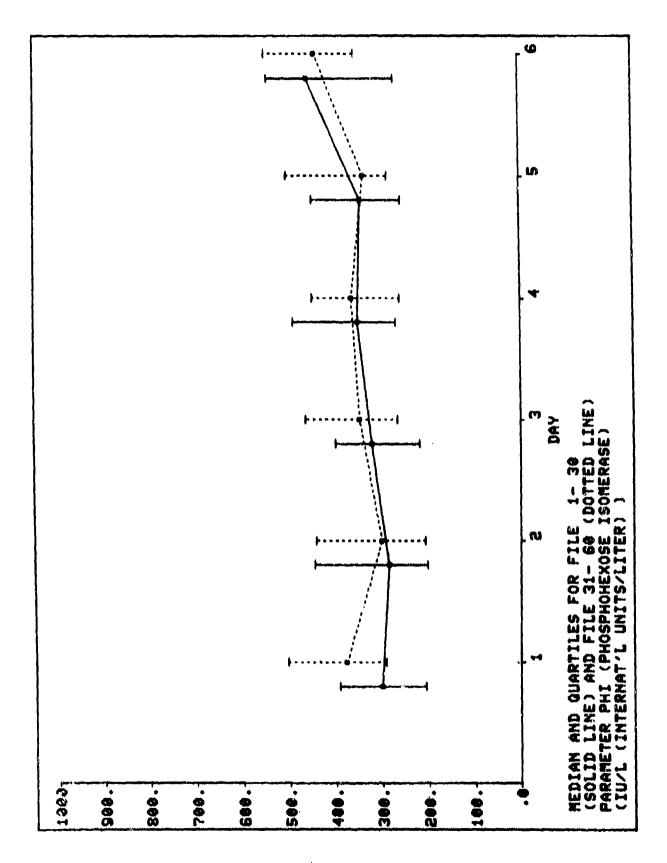


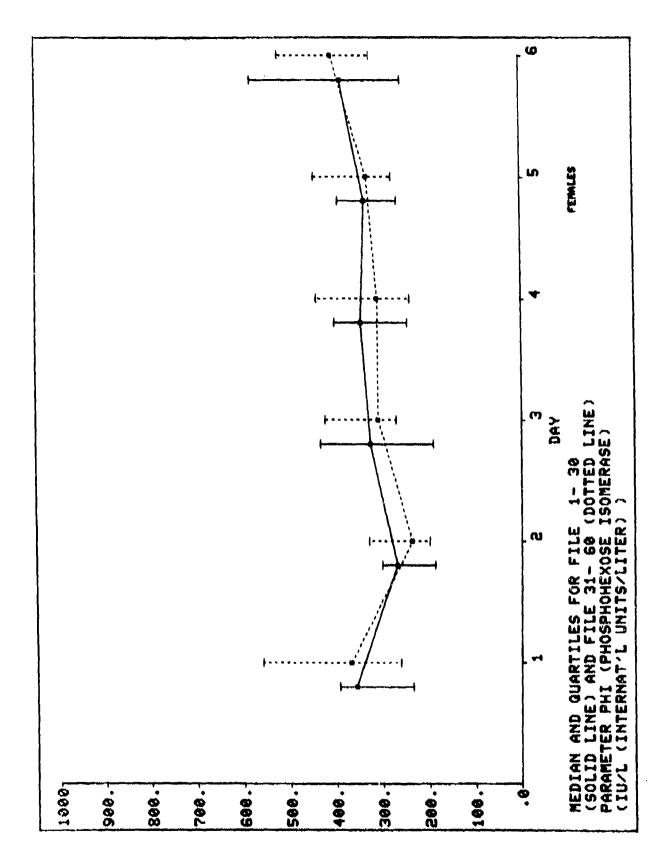




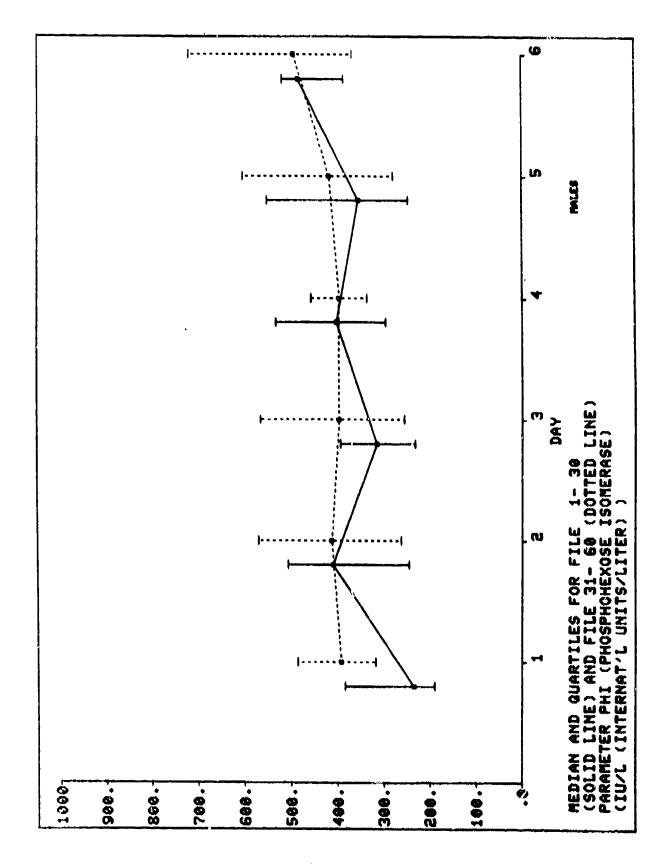


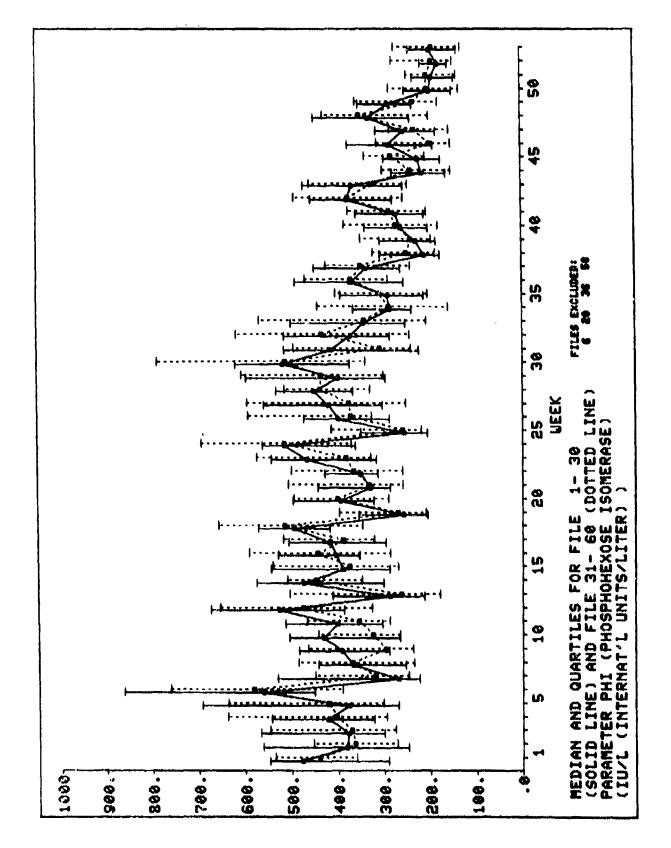
English Salt Car



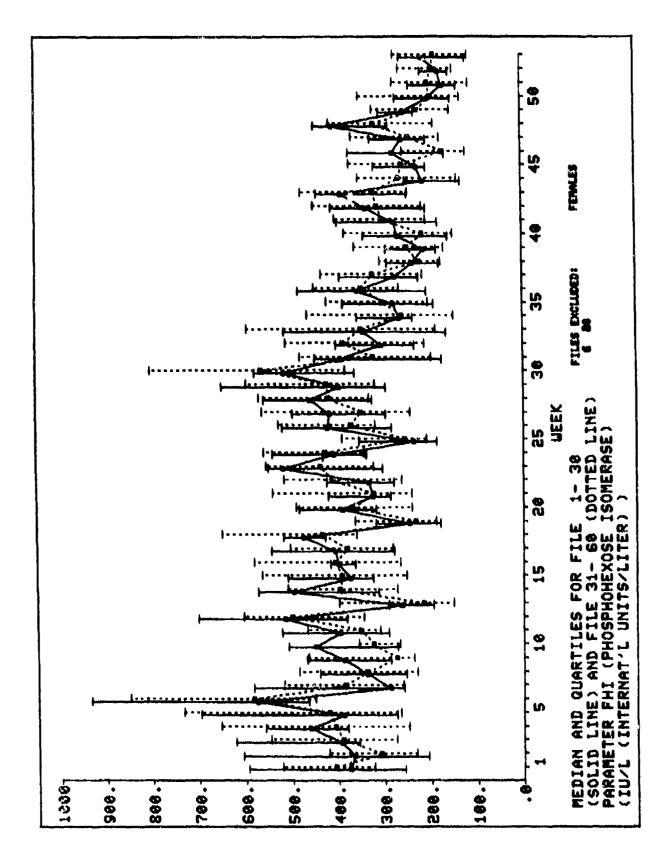


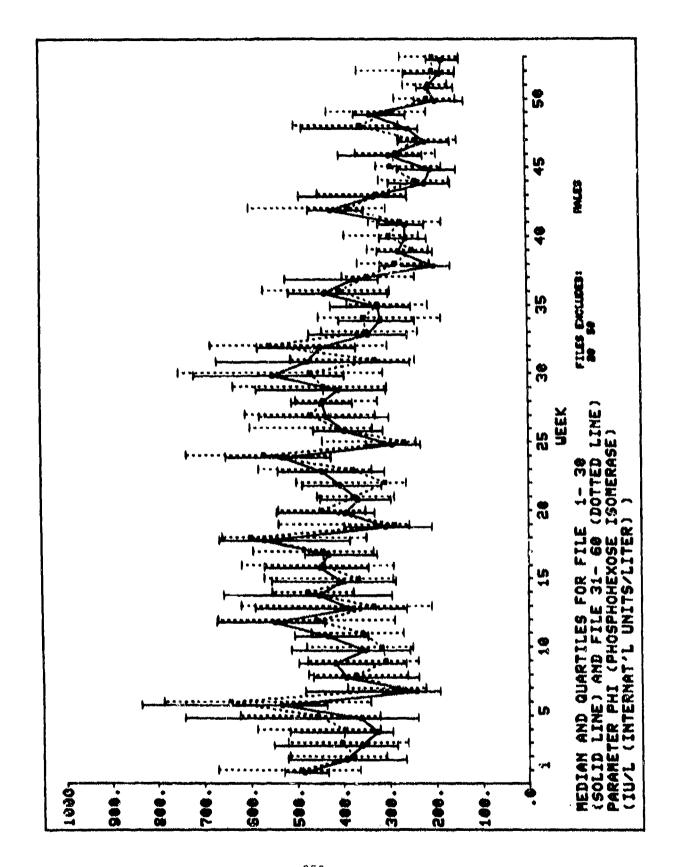
was to that a constraint of the ship at the form of the separate of the ship has been ship and the ship was the separate of the ship was the ship wa





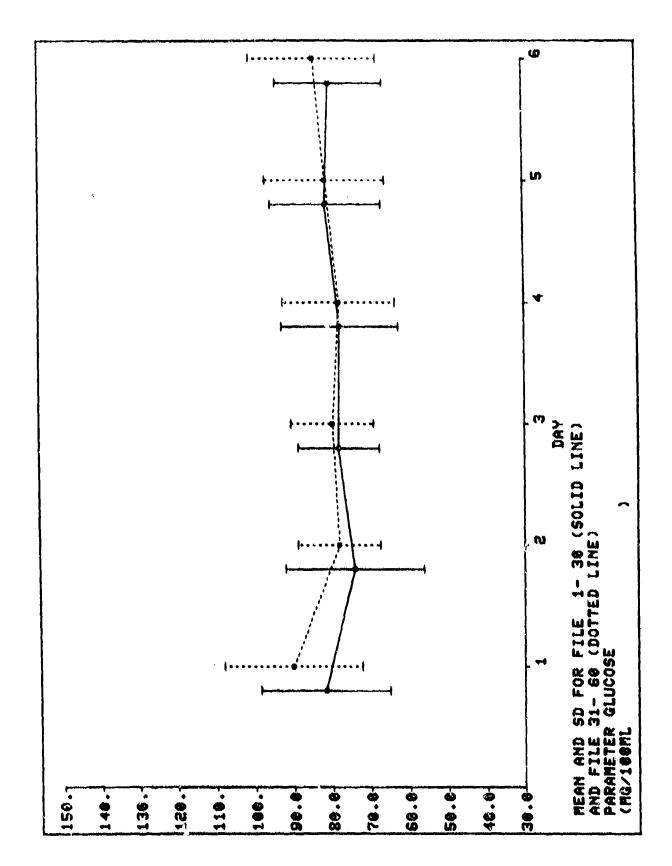
Sept 199 and the section

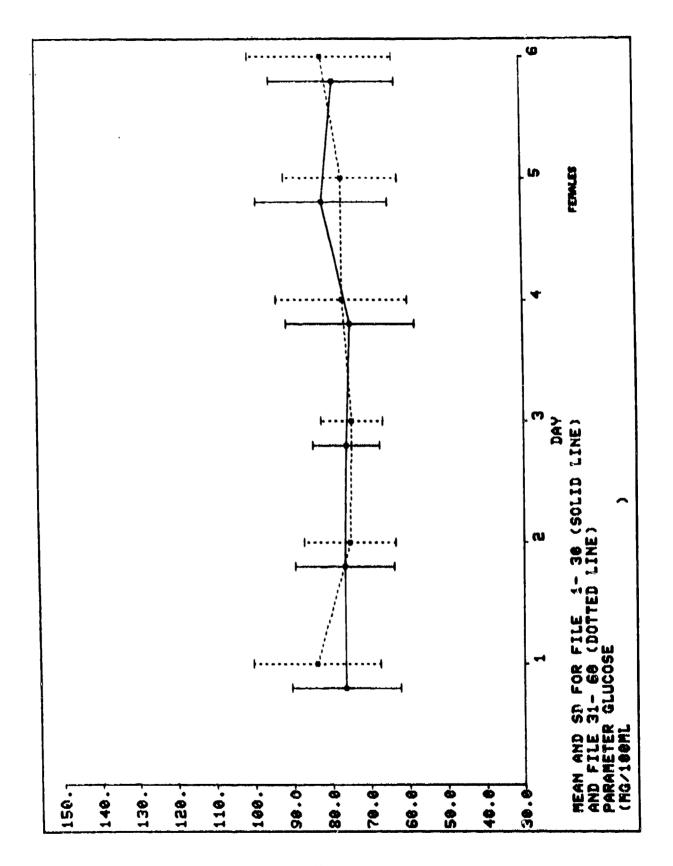


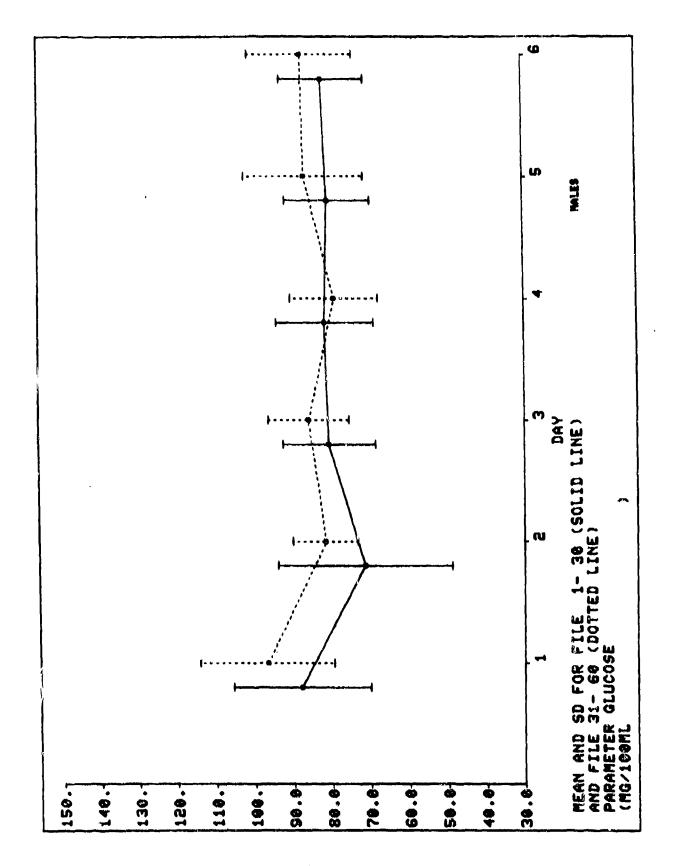


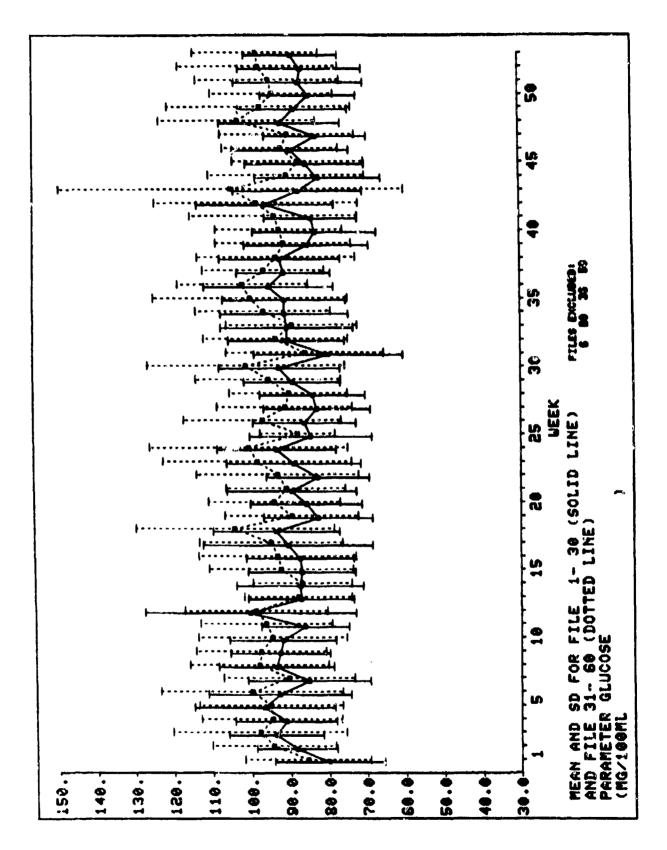
a married animal participation of the

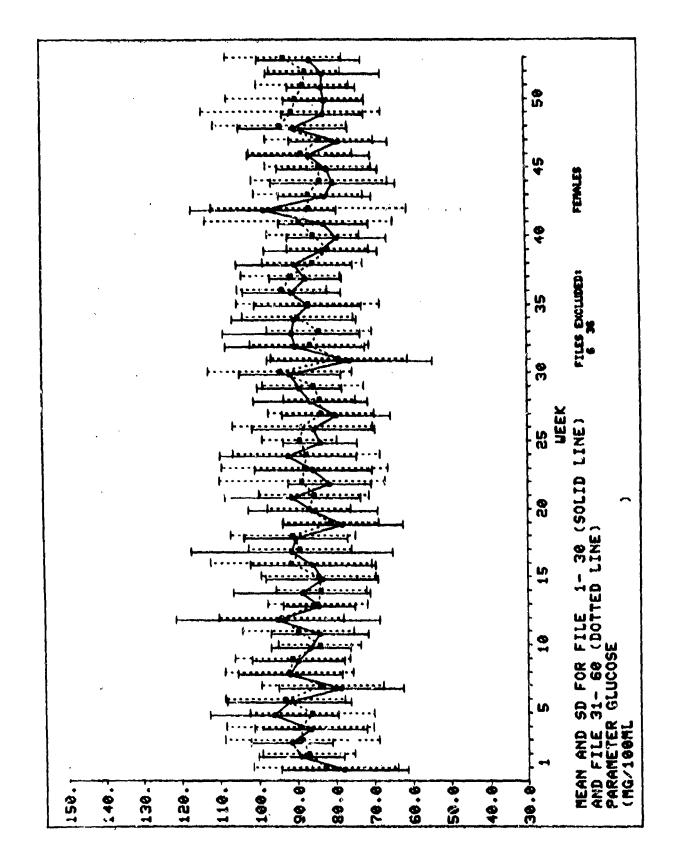
But and the graduate of the control

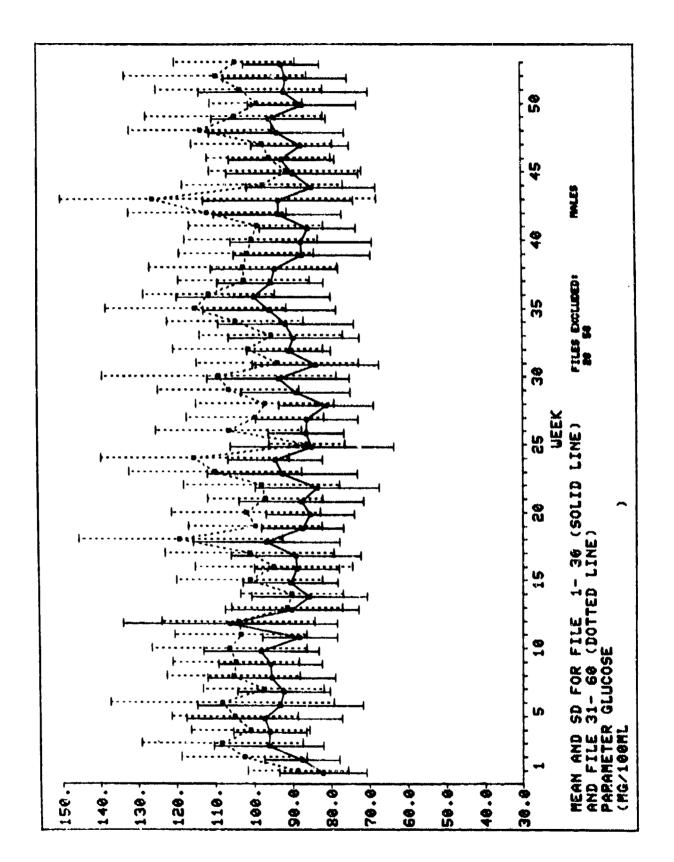


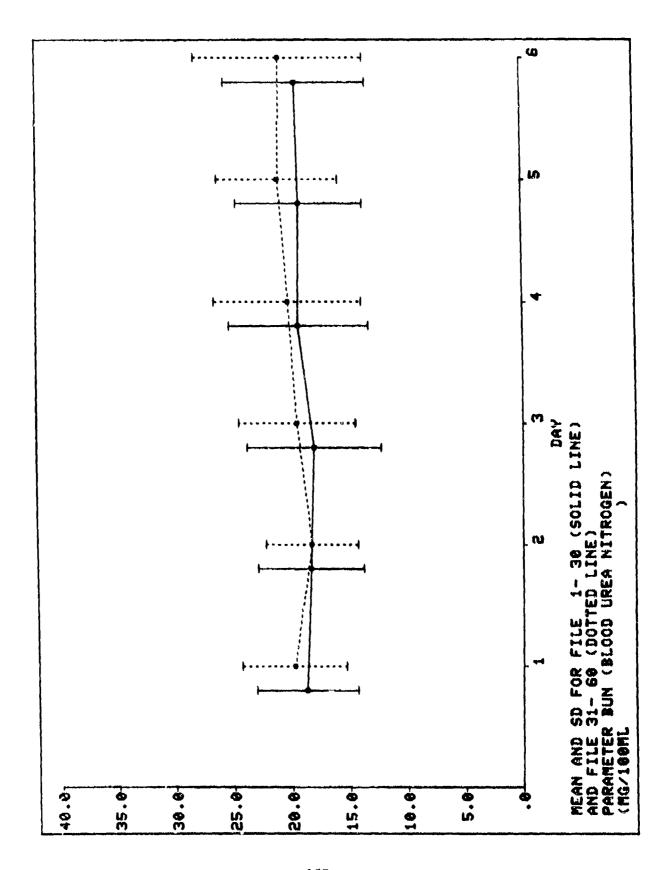




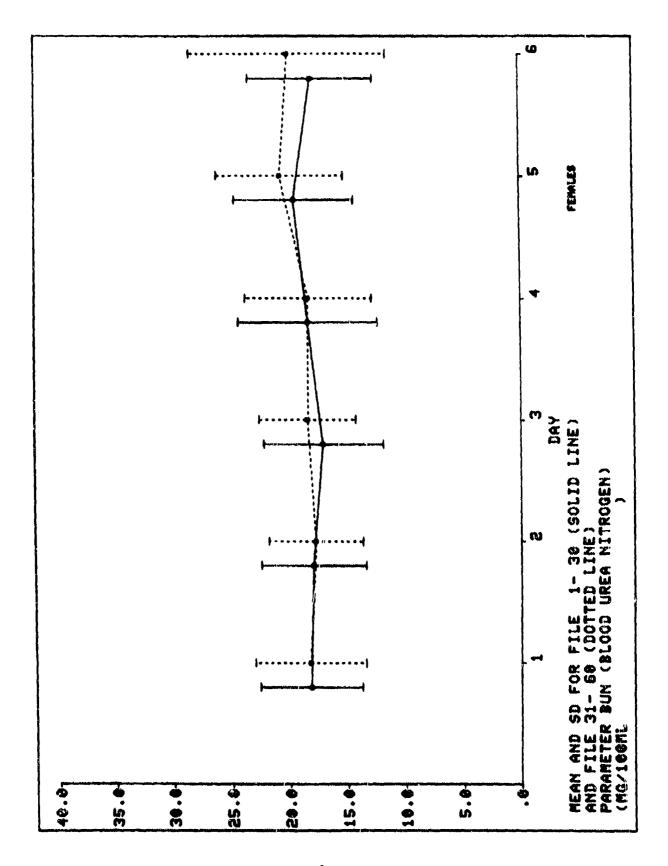


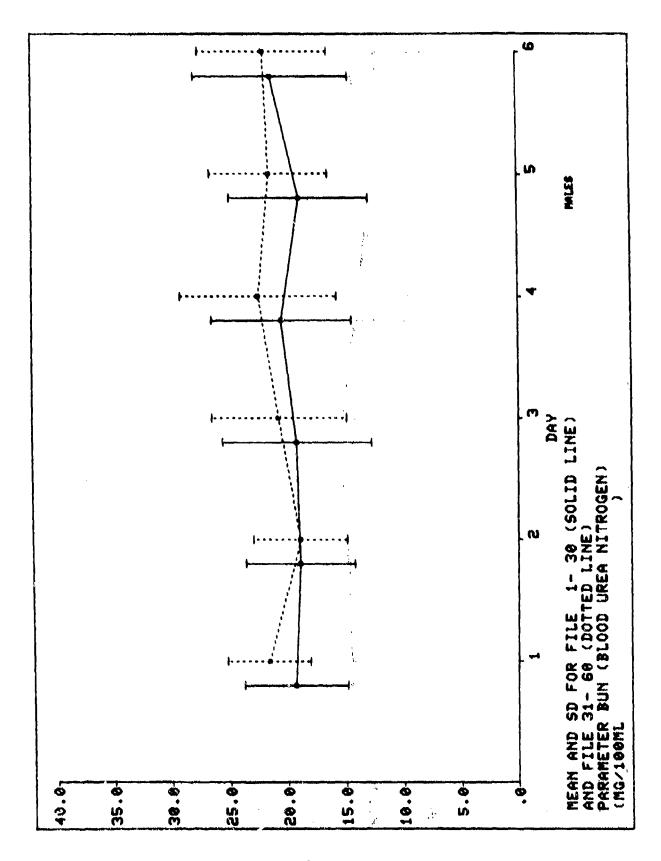


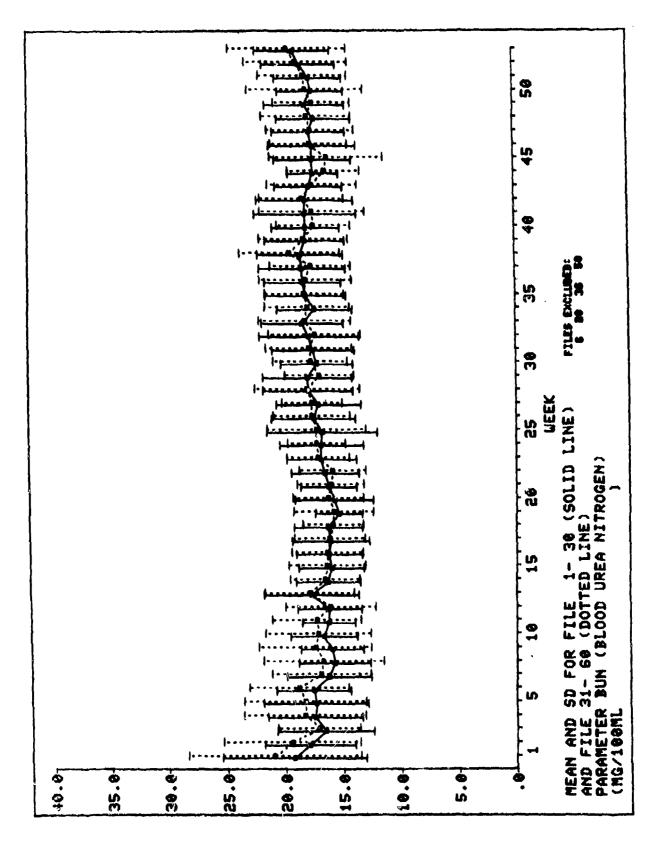




the second the state of the second second

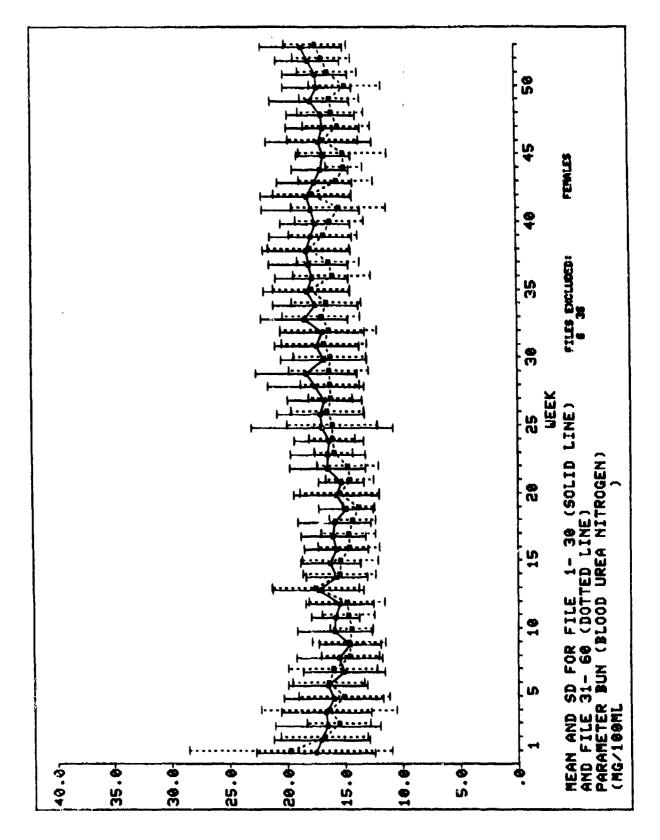


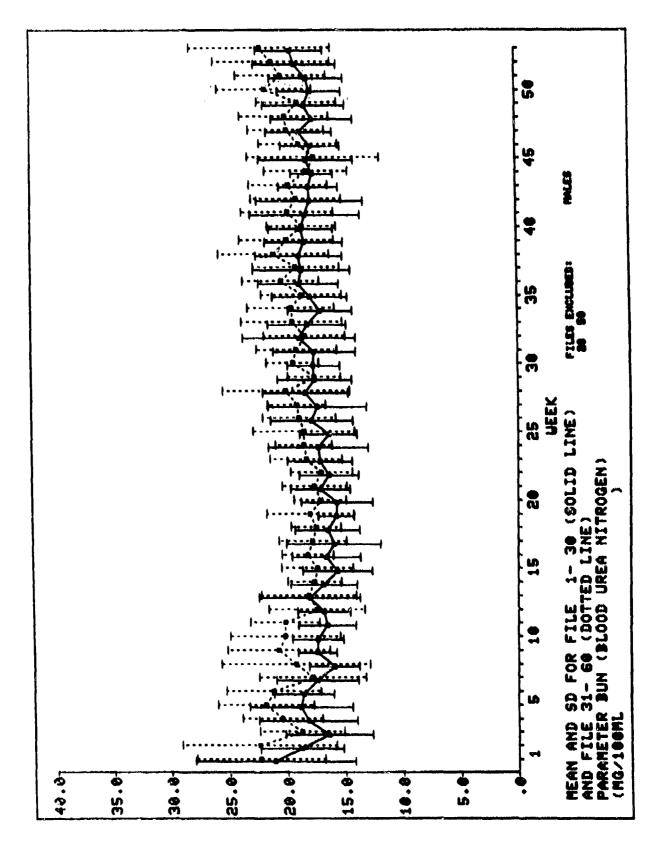




र प्रकार के किया नामिक्स में कर किया किया के मान्य के अपने मान्यक्र सुरक्षि मान्य के नामिक्स के मान्य कर मान्य

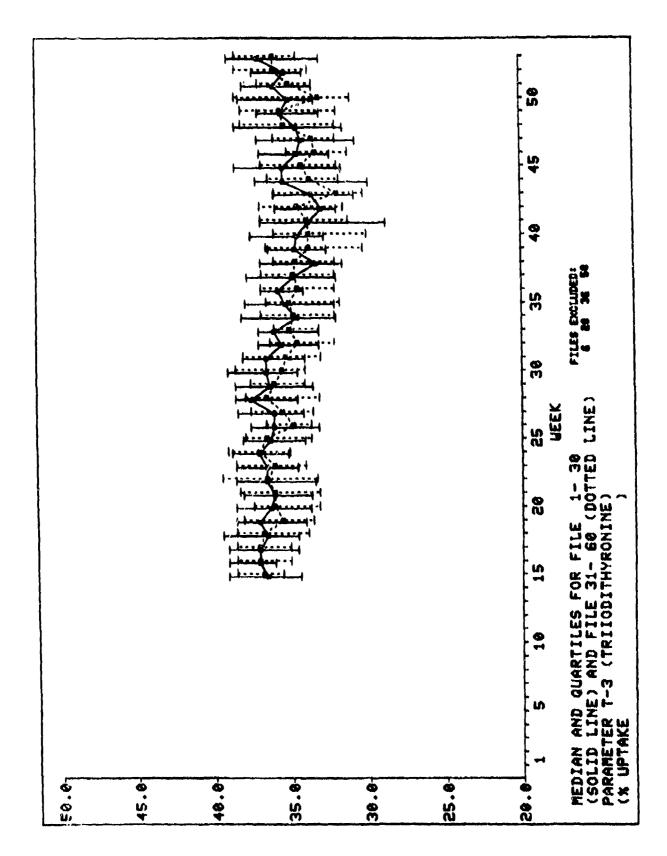
opposition of the end



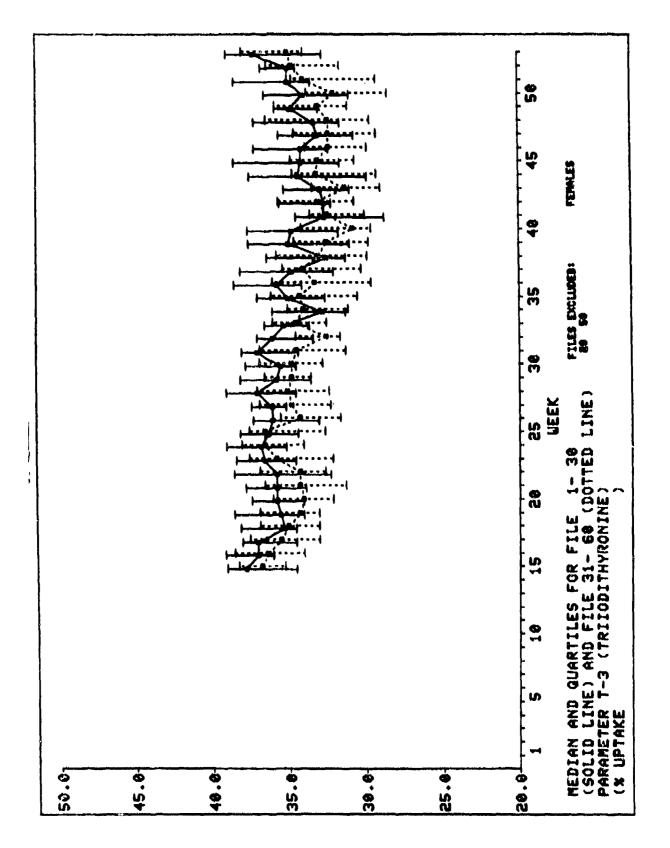


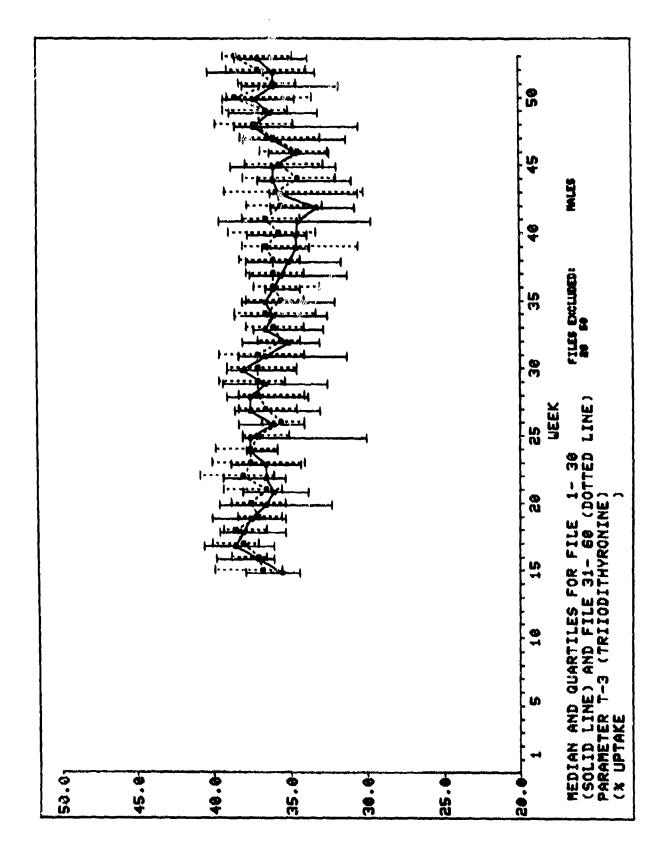
## Thyroid Parameters

The plots for these data begin at week 14. They were not analyzed at the beginning because of delays in arrival of necessary apparatus and reagents. Serum has been preserved, and these data can be retrieved.



 $\chi_{\mu}(\gamma) \to \gamma(1) = + \gamma^{\alpha}$ 

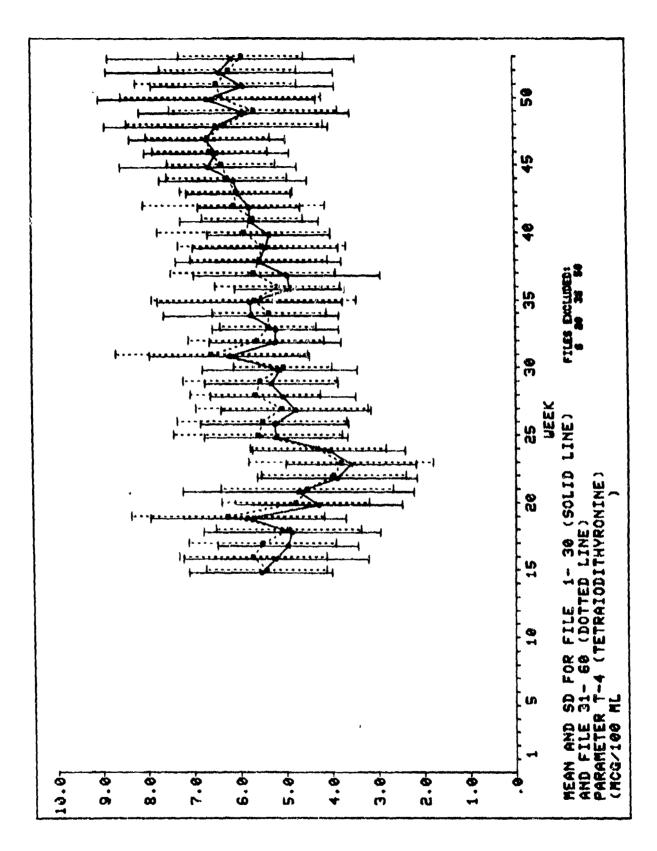




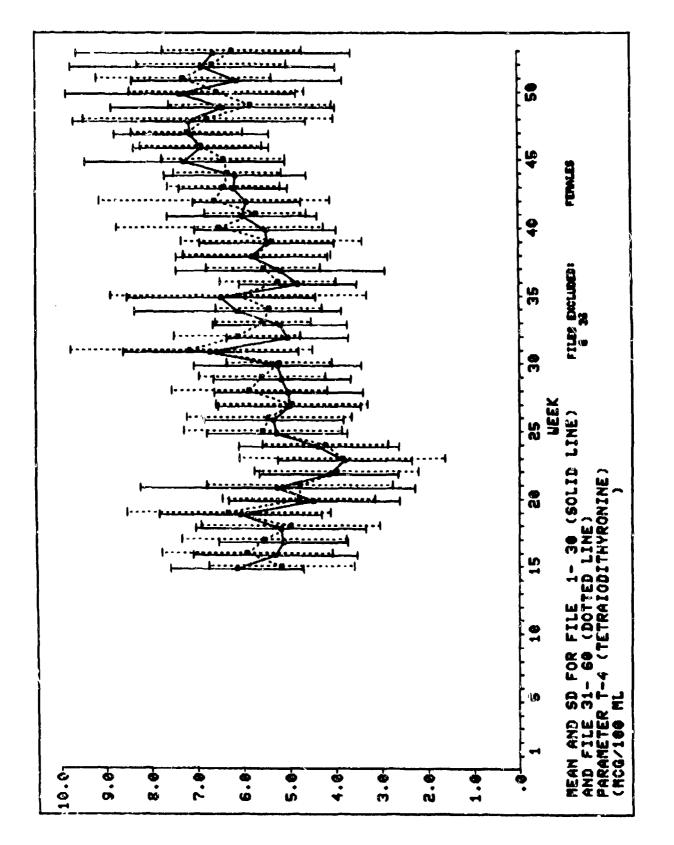
是一个时间,我们就是这种的人,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们 1997年,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们就是一个时间,我们

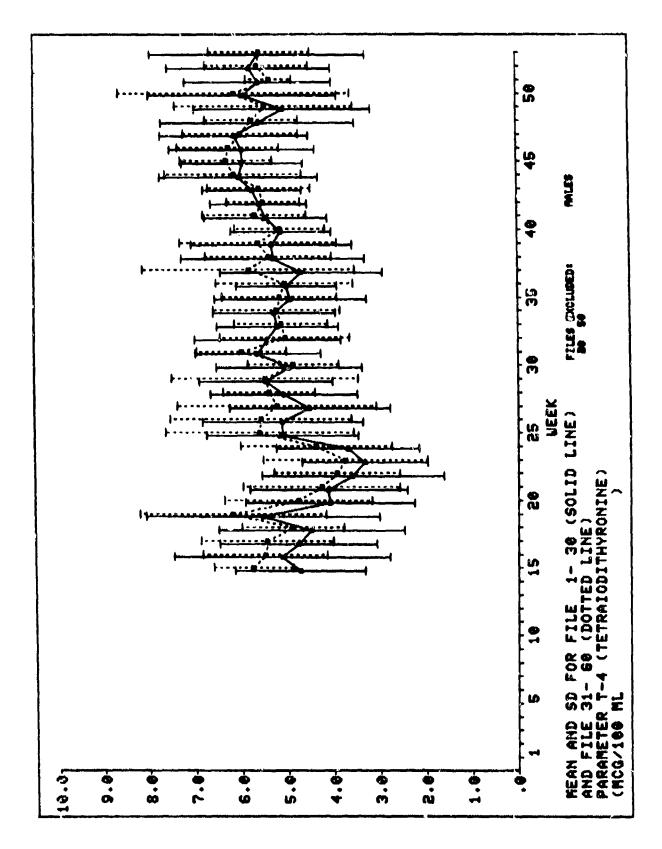
Acres 6 Carlos

DANGAR GARANTAN SANGAR SA

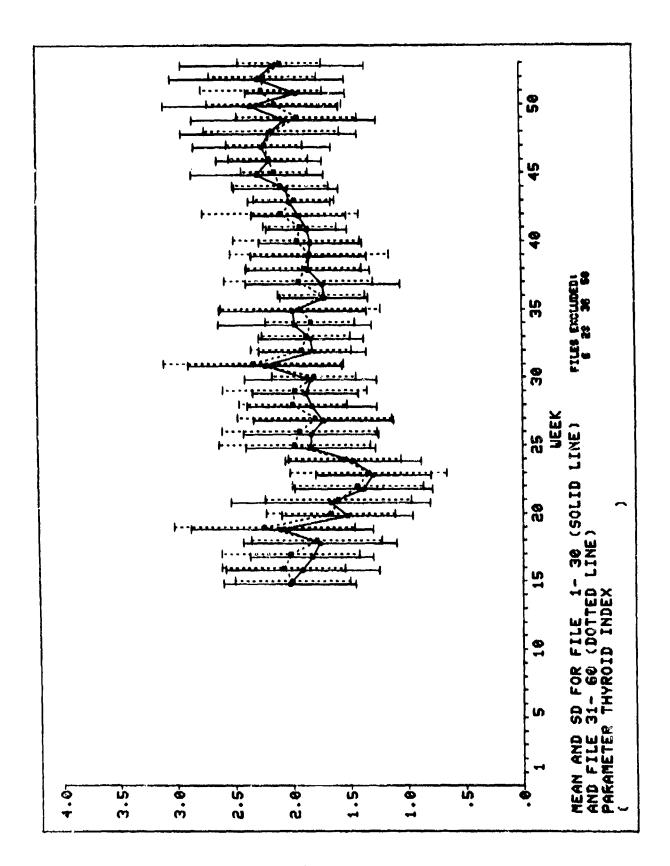


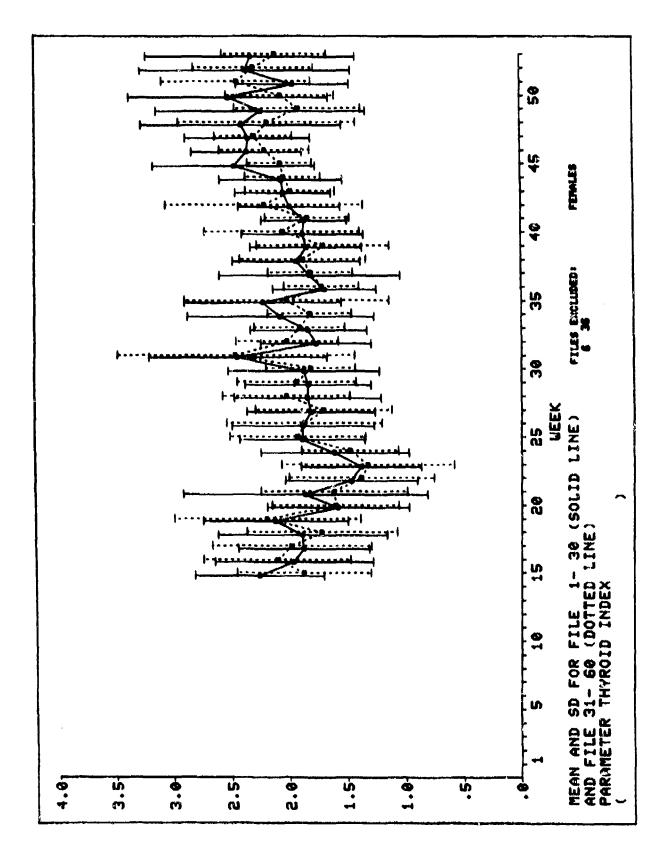
两点的变形 种类形式 人名西西伊 (1996), 1.网络新山野岛,155 (1996), 155 (1996), 155 (1996), 155 (1996), 155 (1996), 156 (1996),

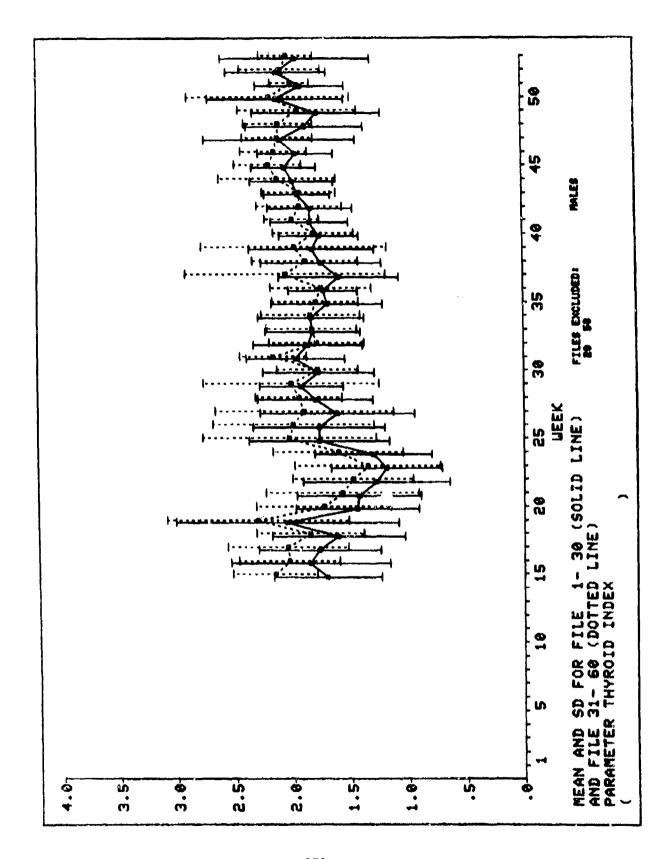




The same the same of the same



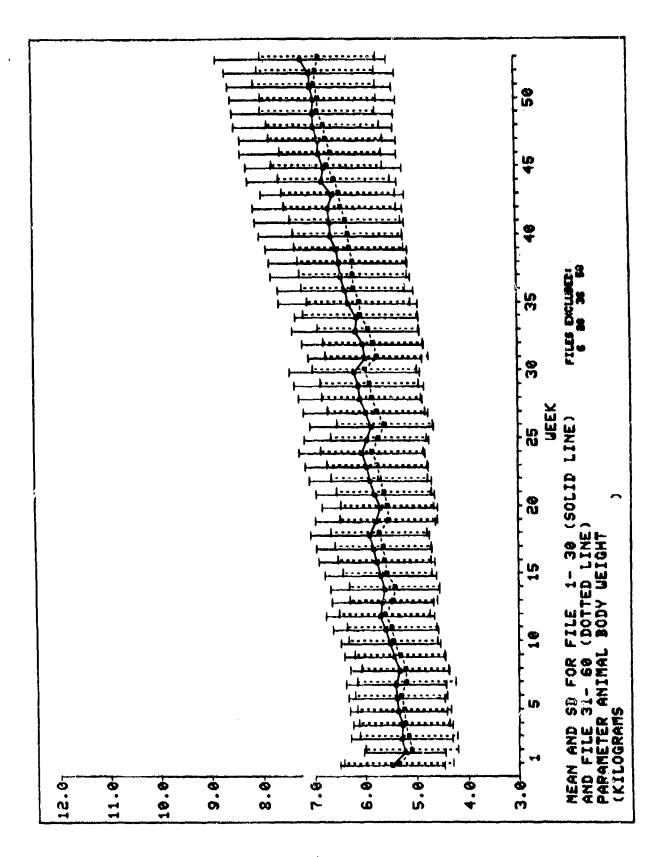




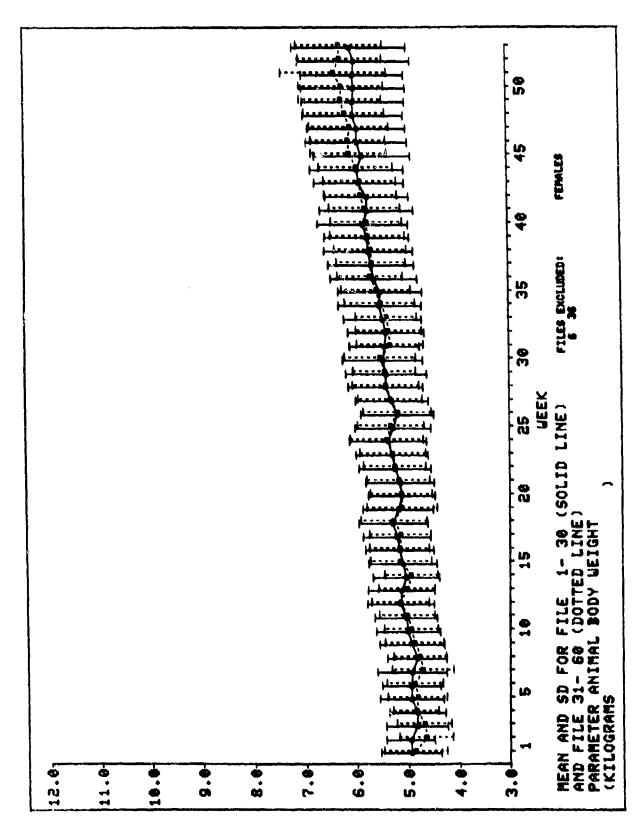
The Allest to Provide the Manual Control of the Con

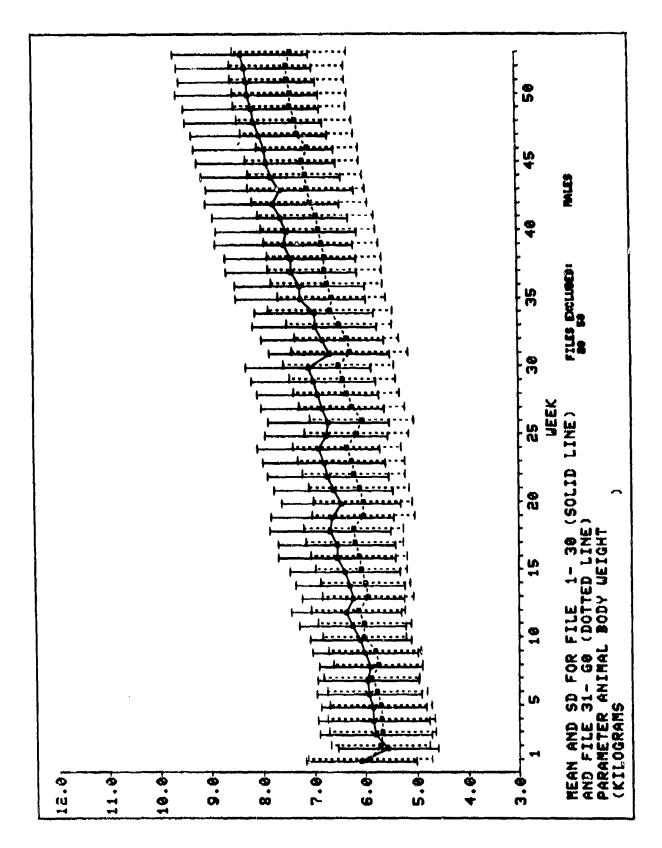
## BODY WEIGHT

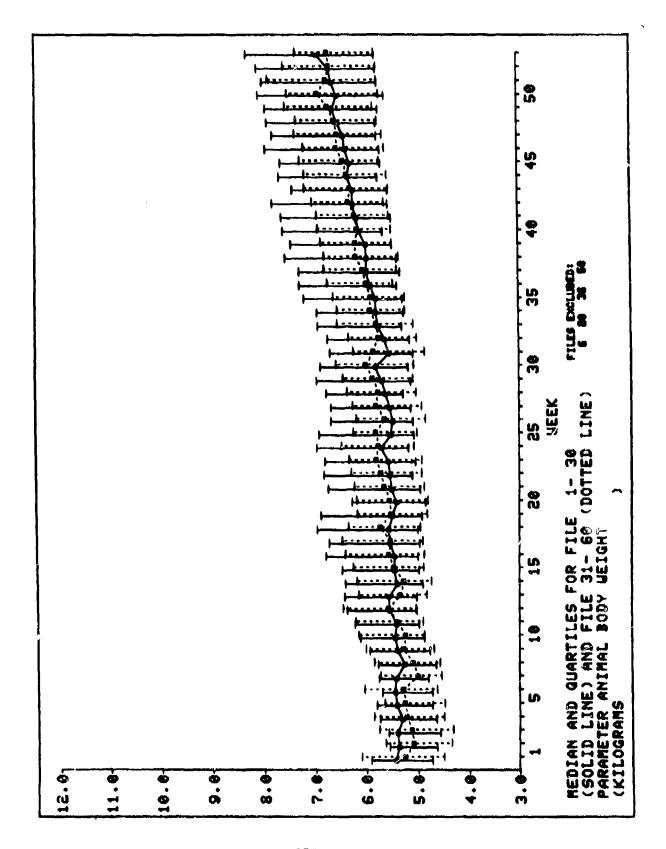
Body weight measurements did not have a normal distribution and could not be adequately transformed. The distributions containing both female and male data were bimodal because the males were much heavier than the females. The following data includes plots of means with standard deviations and of medians with quartiles. Plots are also shown for the mean and standard deviation of body weight ratios in which the first weight of each animal was taken as the standard, and all raw data for each animal were recomputed as a ratio to initial weight. These derived data were then used to calculate mean ratios for each data point. For these ratio plots, the first data point is, by definition, unity with zero dispersion. Growth rates and variation in growth rates are readily apparent on these plots.

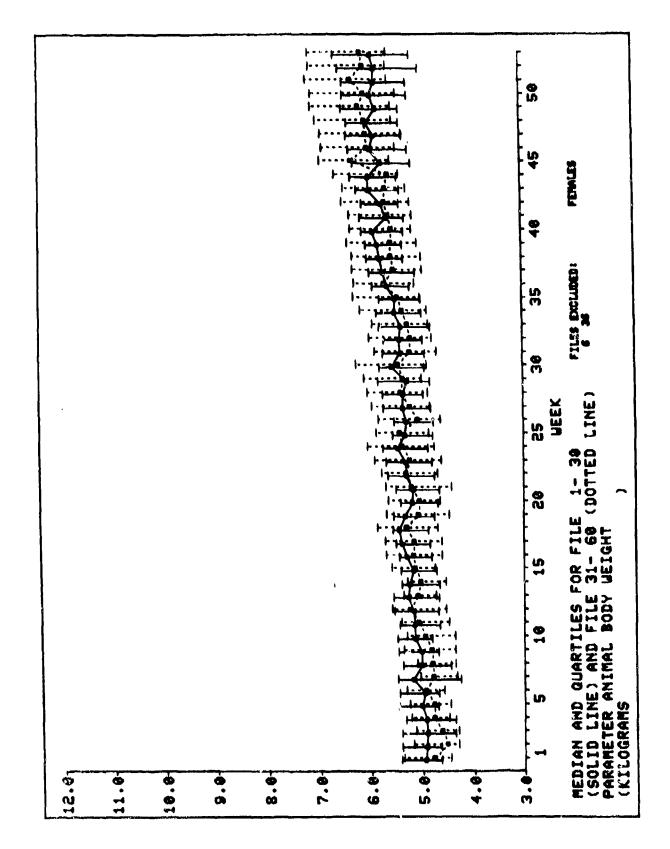


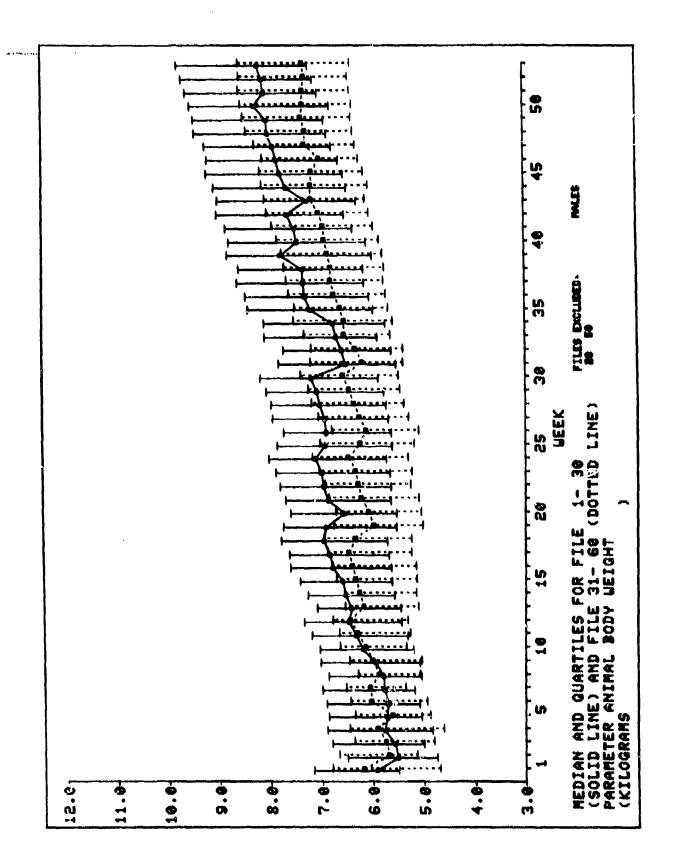
CHE THE STATE OF THE STATE

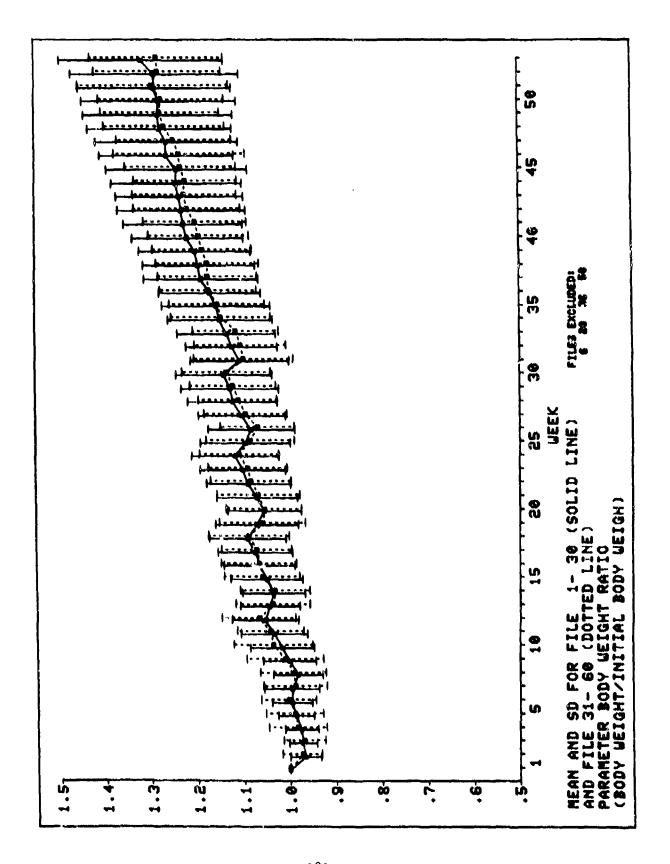


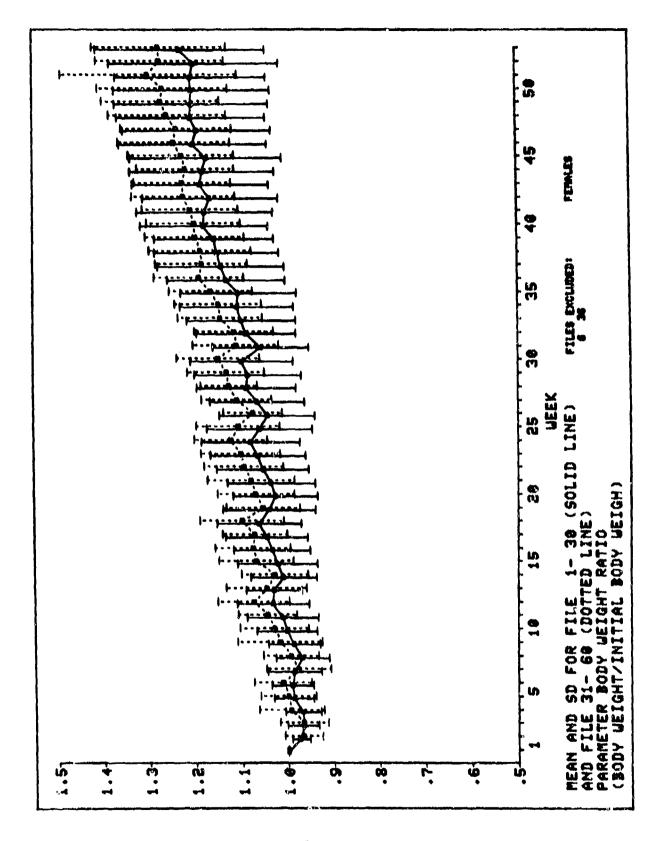


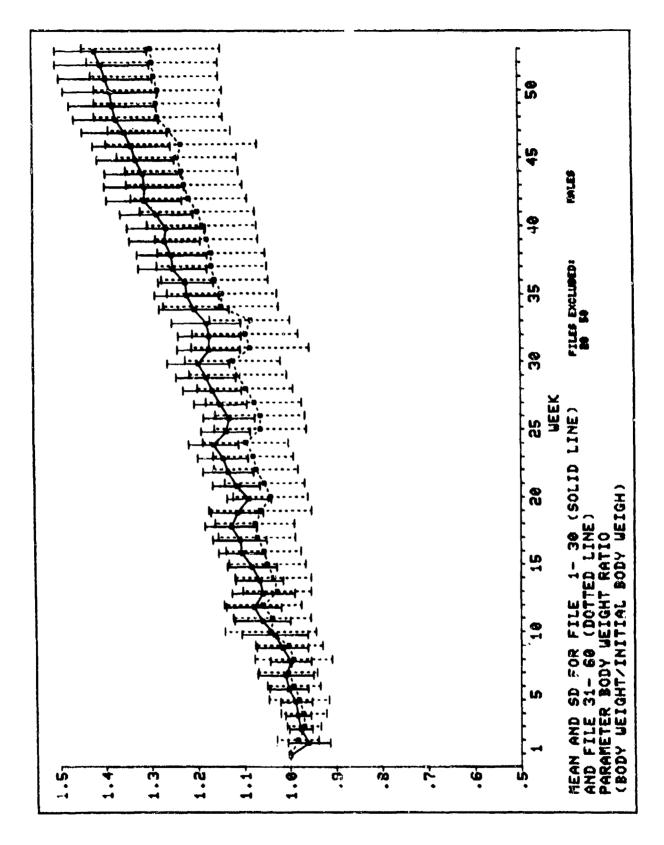






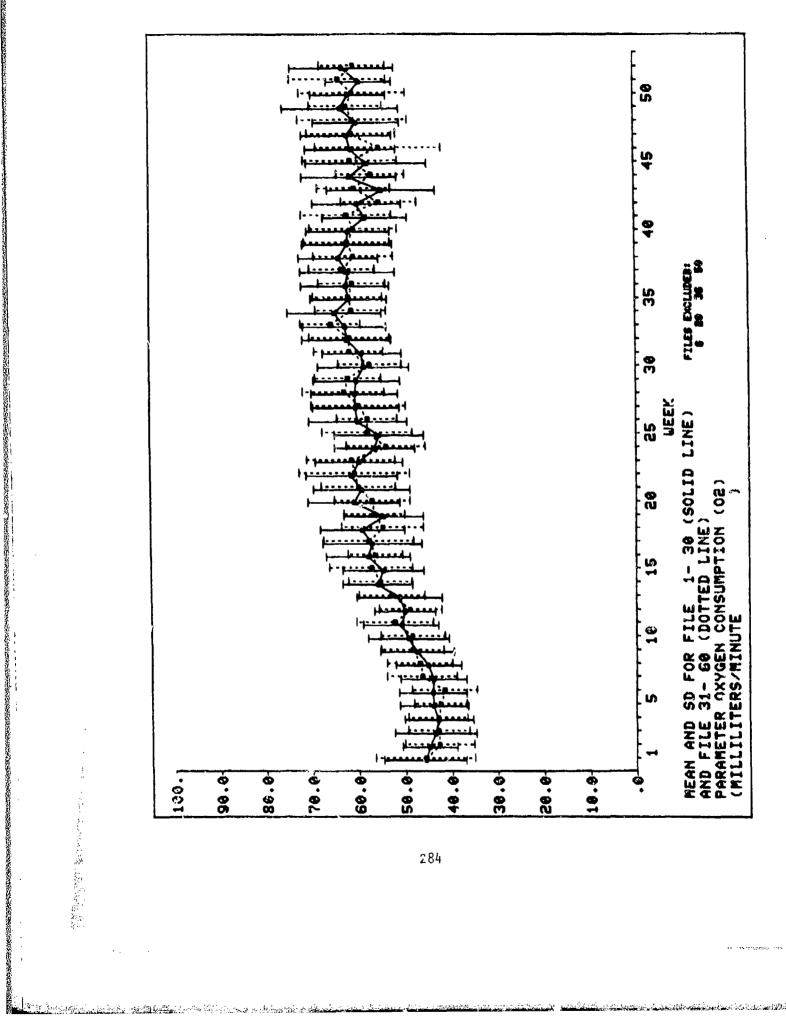


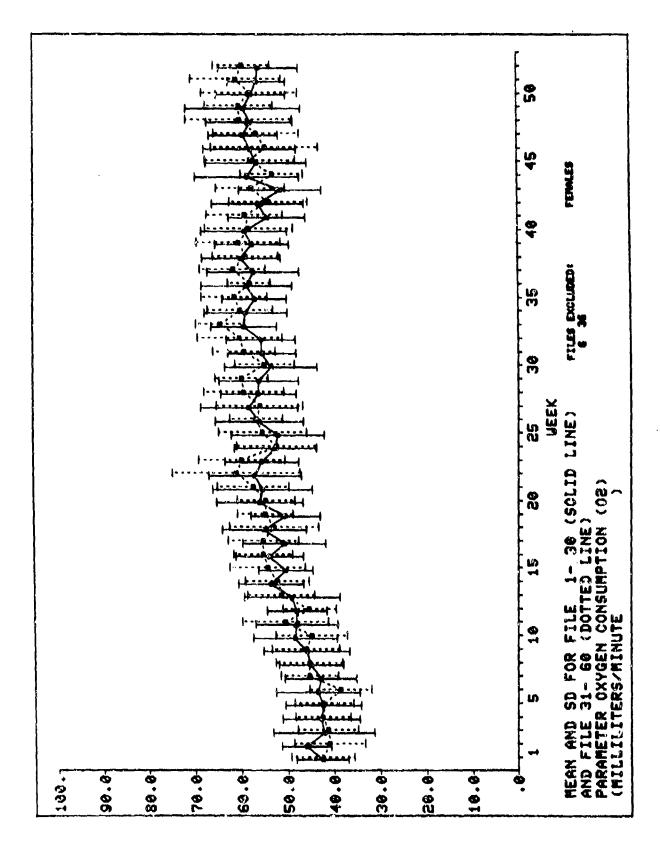


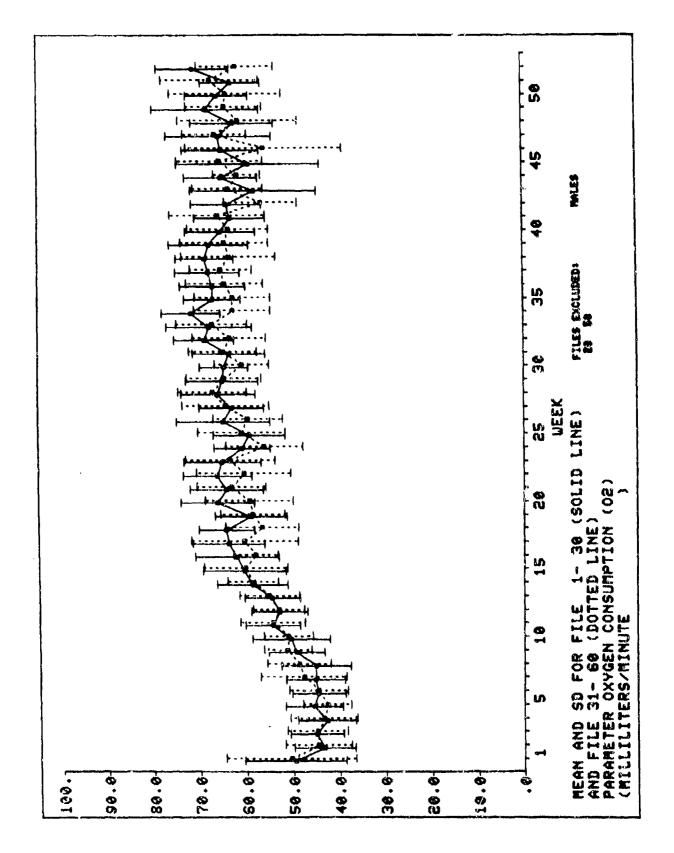


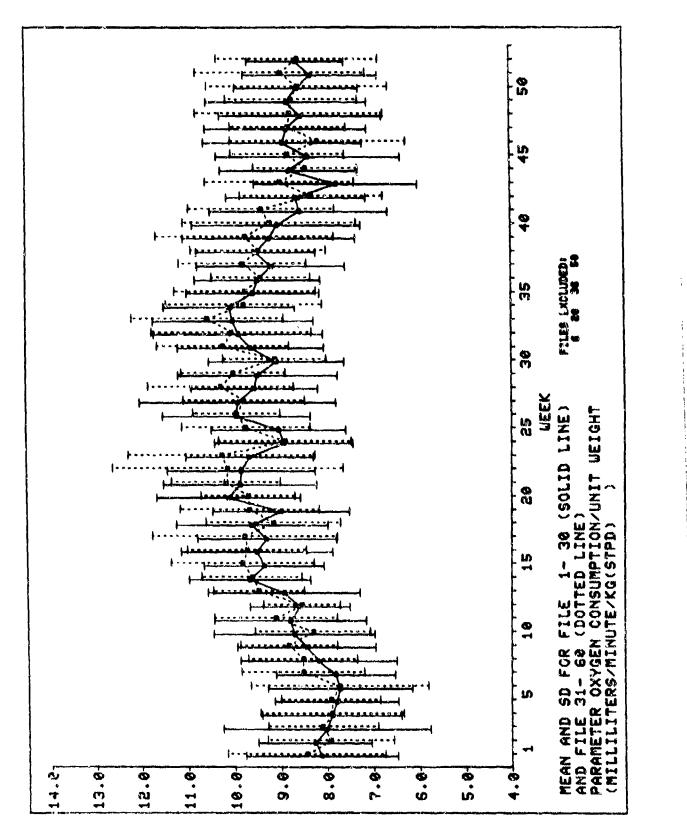
## RESPIRATORY GAS ANALYSIS

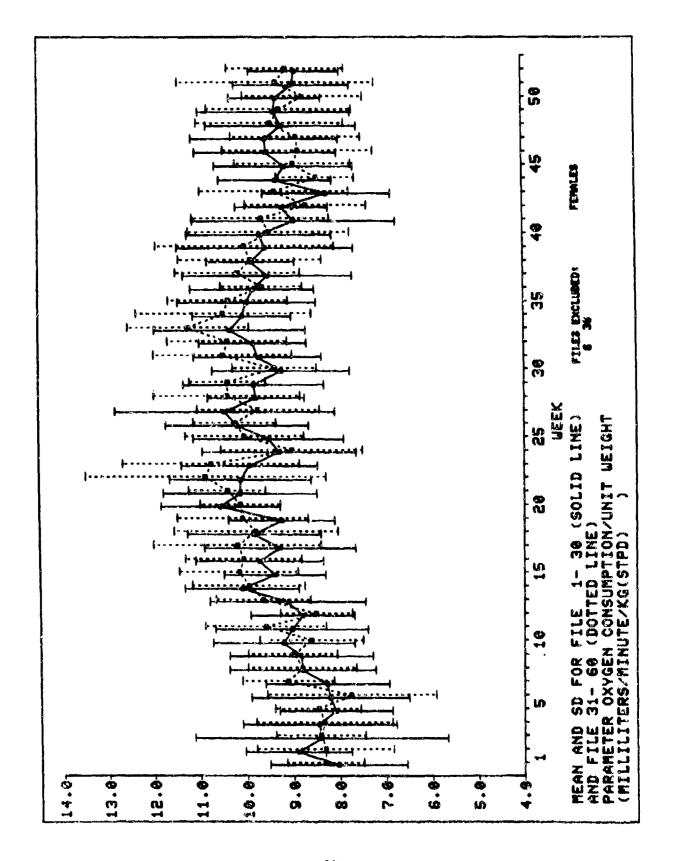
Oxygen consumption rate and carbon dioxide production rate were measured at room temperature, humidity, and pressure and then averaged over the measurement period (approximately 22 hours) to provide a plot of rate in ml/minute. The same raw data were then corrected to standard gas conditions. (This correction is based on average temperature, humidity, and pressure in the laboratory and is not as accurate as can be achieved using precision techniques on a single animal.) The corrected data is then averaged over the measurement period and divided by body weight to produce a plot in ml/minute/kg at standard gas conditions. The average oxygen consumption and carbon dioxide production rates are used to compute the respiratory quotient for each animal from which the group means are computed and plotted.

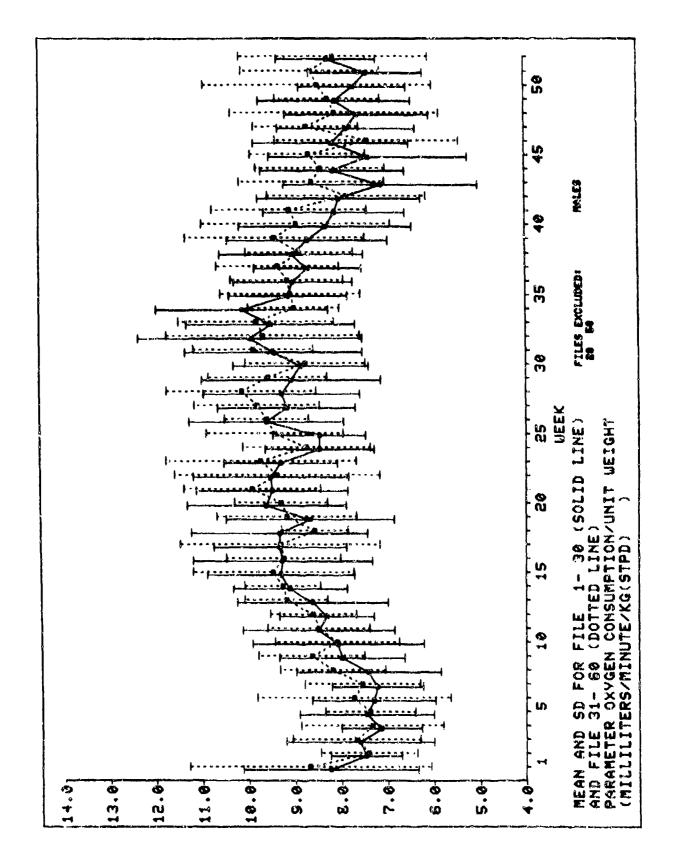


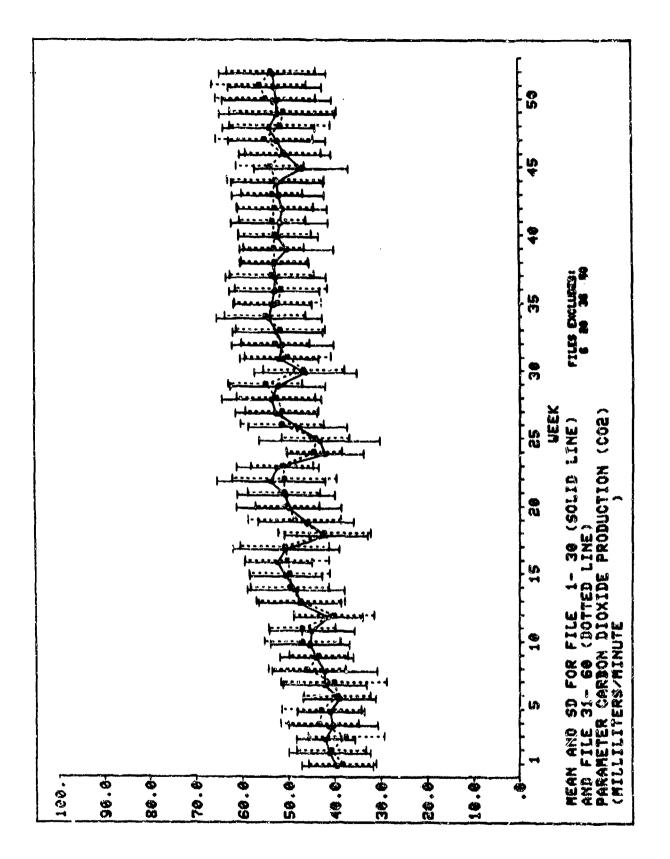


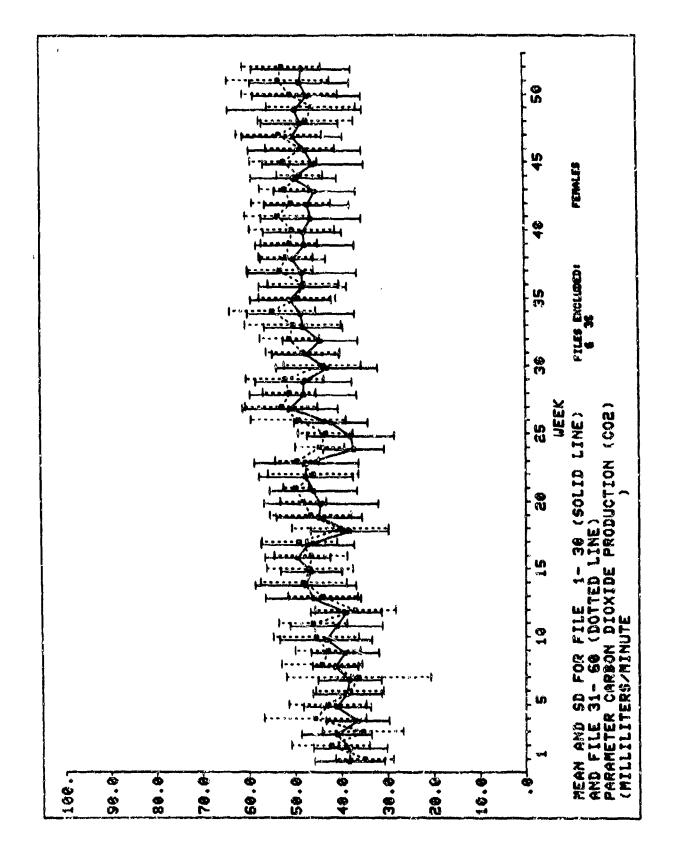


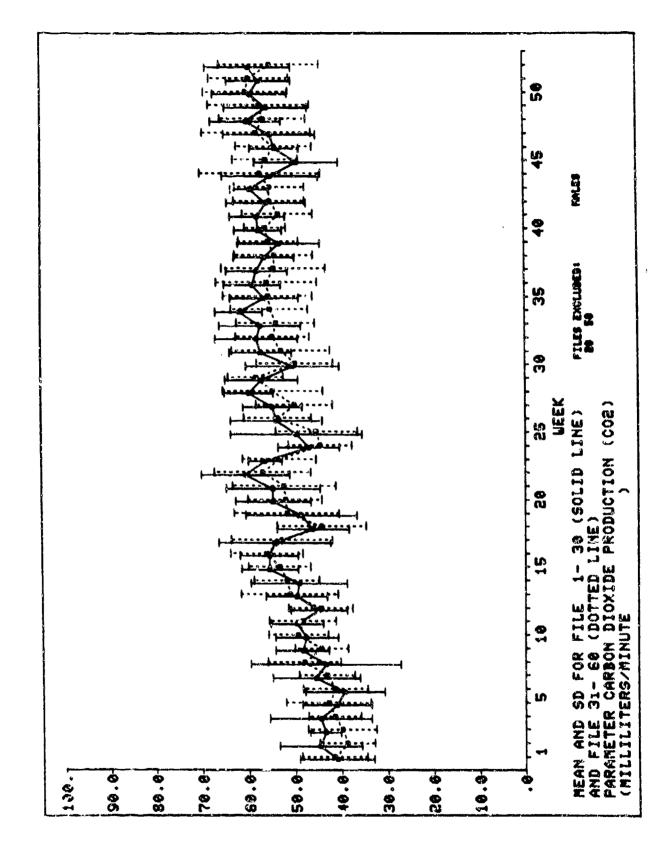


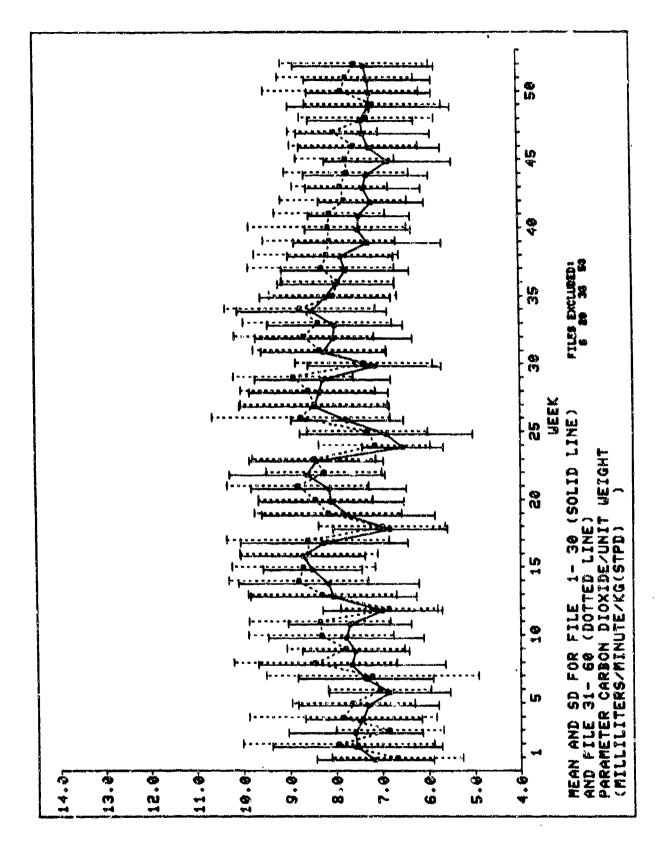




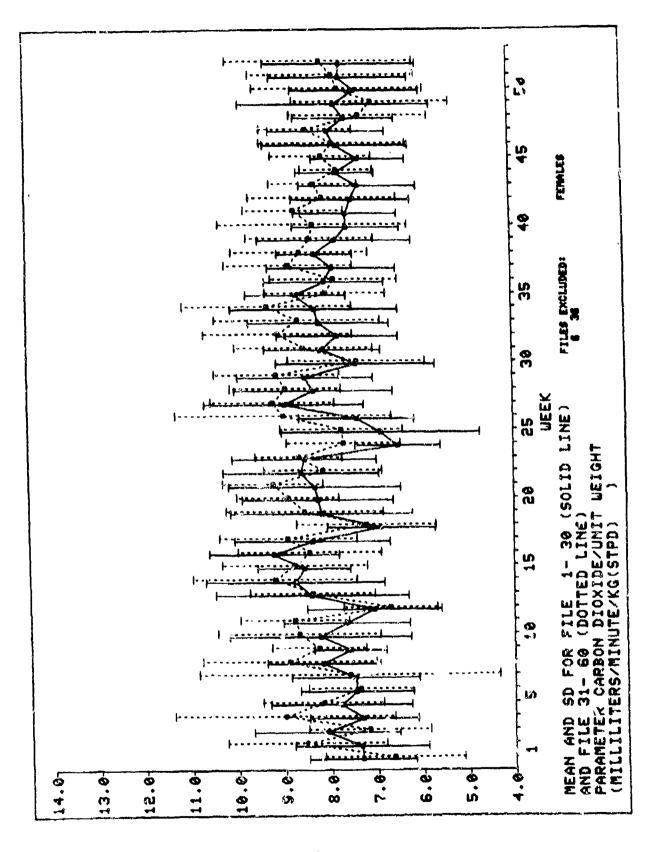


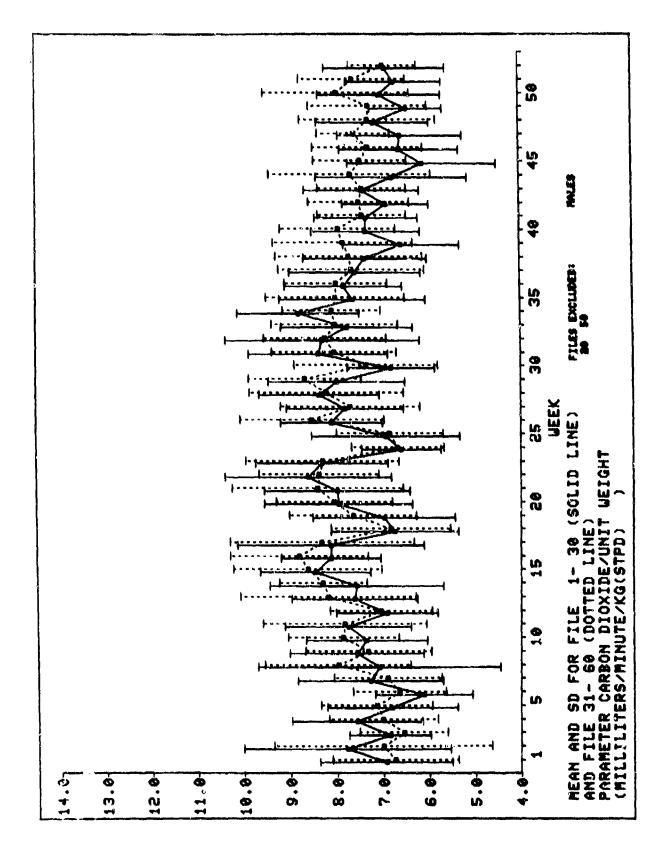


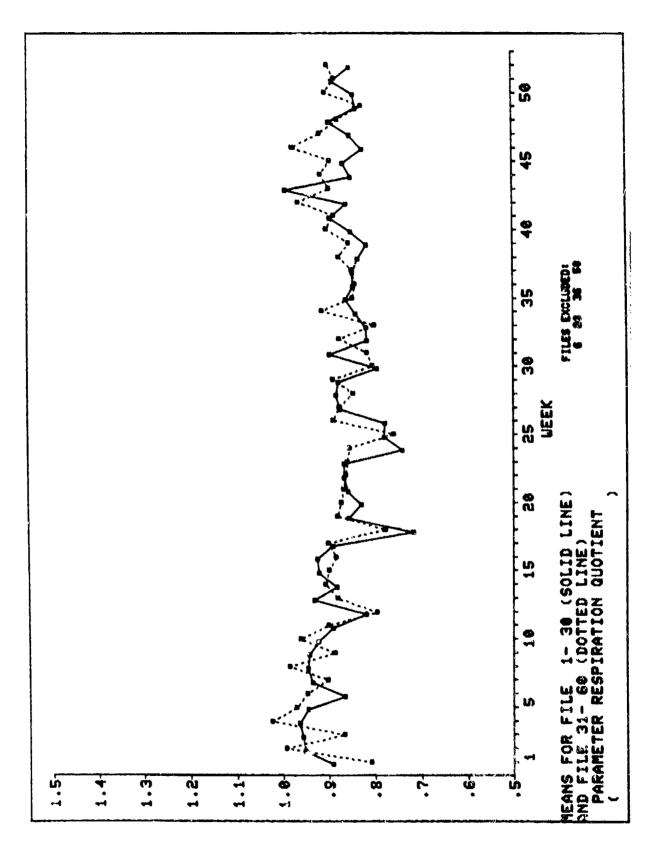


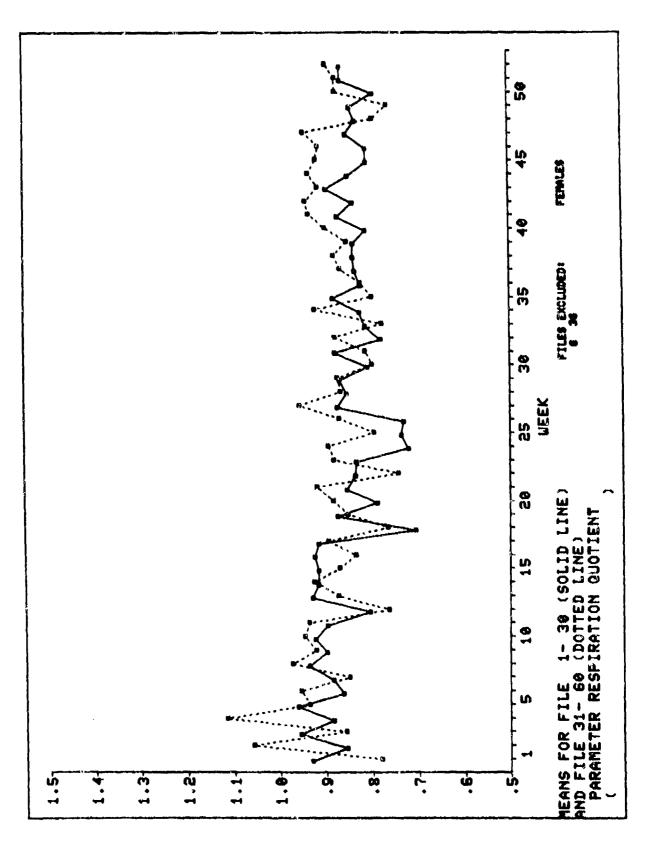


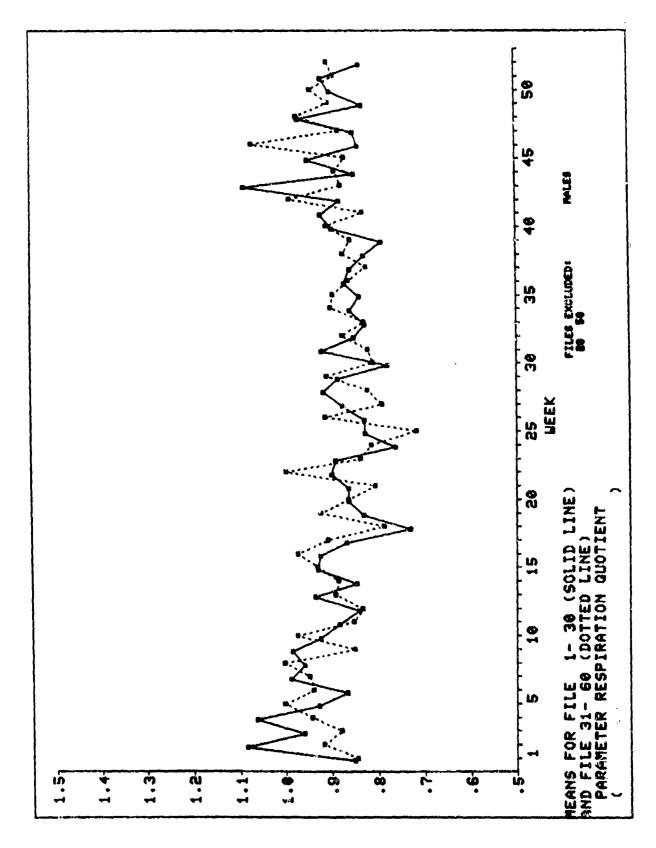
and the state of the











## STATISTICAL SUMMARY

The statistical results are summarized in Table VIII. Parameters are arranged in the same order as the plots. The first three rows for a given parameter are for the data taken during the first six days of the experiment. The first row, labeled M&F, is for all animals in the group; the second row, labeled F, is for females only; and the third row, labeled M, is for males only. The last three rows for a given parameter are for data taken at weekly intervals. The row sequence is again male and female, female only, and male only. Transformation codes are shown where applicable. The degrees of freedom are in the column labeled dF and the F ratio is in the column labeled F. The numbers in the alpha columns are the probability that the observed difference could be due to chance alone. A positive sign in the Z column means that the controls tend to be higher than the experimentals and a negative sign means the experimentals tend to be higher than the controls.

TABLE VIII

18.252

STATISTICAL SUMMARY

Af F F F F F F F F F F F F F F F F F F F	dF 1,58 1,30 1,26 1,24 1,24	F α 2.0έ .16	дЬ		(ANONA)	TEST	
M&F  M&F  M&F  M&F  M&F  M&F  M&F  M&F	1,58 1,30 1,54 1,28 1,24				ಶ	7	ಶ
F 1,30  MEF 1,26  MEF 1,24  MEF 1,24  MEF 4 1,26  MEF 1,26	1,30 1,26 1,28 1,28		5,290	0.62	89.	-0.81	.42
M 1,26  MEF 1,24  MEF 1,24  MEF 1,54  MEF 4 1,58  MEF 7 1,58	1,26 1,28 1,24	·	5,150	1.13	.35	-6.22	.82
M&F  F  M  M  M  M  M  M  M  M  M  M  M  M	7,54 1,28 1,24		5,130	99.0	-65	-1.10	.27
F 1,28  MEF 1,24  MEF 1,24  MEF 1,26  MEF 4 1,26  MEF 7 1,26  MEF 7 1,26  MEF 8 1,26  MEF 8 1,26  MEF 9 1,26  MEF 9 1,26  MEF 1,26  MEF 1,26  MEF 1,26  MEF 1,26  MEF 1,26	1,28 1,24	•	52,2792	0.50	-99	0.00	.99
M&F  M  M  M  M  M  M  M  M  M  M  M  M  M	1,24	•	52,1447	0.49	£6.	0.47	.63
M&F  H	0 1	•	52,1241	0.42	-99	-0.53	.59
F 1,30  M 1,26  F 1,26  M 1,24  M 1,24  M 4 1,26  M M 4 1,26  M M 4 1,26  M M M M M M M M M M M M M M M M M M M	٥٥,1	0.01	5,290	0.97	44.	1,7.0	.73
N 1,26  F 1,54  N 1,24  N 1,24  N 1,24  N 4 1,26  N 6 1,54  N 7 1,26  N 8 1,26  N 8 1,26	1,30		5,150	0.24	.95	0.15	88.
M&F F F H 1,28 T 1,24 T 1,24 T H H H H H H H H H H H H H H H H H H	1,26		5,130	1.21	.ځ۱	0.00	ę.
F 1,28  M	1,54		52,2795	0.47	29.	1.37	.17
On MSF 4 1,24  F 4 1,58  MSF 4 1,26  MSF 4 1,26  M 4 1,24  MSF 7 1,24  MSF 7 1,24  MSF 7 1,26  M 8 4 1,24  MSF 7 1,26	1,28		52,1448	0.54	9,	1.34	3
on MSF 4 1,58  K 4 1,30  K 5 4 1,26  K 6 1,54  K 7 4 1,28  K 7 1,28  K 8 7 1,28  K 8 7 1,28  K 9 1,24  MSF 1,26	1,24		52,1243	0.51	.99	1.00	.32
F 4 1,30  MEF 4 1,26  F 4 1,24  MEF 4 1,24  MEF 1,30  M 1,26	_		5,289	0.28	.92	-0.69	64.
MSF 4 1,26 F 4 1,54 F 4 1,28 MSF 4 1,24 MSF 1,58 M	•		5,150	1.69	41.	-0.30	9/:
MEF 4 1,54 F 4 1,28 M 4 1,24 MEF 1,58 F 1,58 M 1,26	•		5,139	1.14	.34	-0.59	.55
F 4 1,28  M 4 1,24  MEF 1,58  F 1,30  M 1,26	•		52,2781	0.62	.99	0.81	.41
MEF 4 1,24 MEF 1,58 F 1,30 M 1,26	•		52,1440	0.49	-99	0.18	<del>2</del> 8.
МЕF 1,58 F 1,30 М 1,26			52,1237	0.63	-99	0.84	.47
F 1,30	1,58	0.03 .86	5,289	1.08	.37	0.01	96.
1,26	1,30		5,150	1.59	41.	-0.33	.73
	1,26		5,129	1.04	.39	0.36	Ľ
1,54	1,54		52,2779	0.76	<b>8</b> 9.	1.91	.06
1,28	1,28		52,1439	0.83	. <b>8</b> 0	-1.30	61.
1,24	1,24		52,1236	0.76	<b>.8</b> 6	-1.65	.10

\*1 = Square Root 2 = Natural Log 3 = Reciprocal 4 = Square

PARAMETER	SEX	TRANSFORMATION CODE*	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	DIFFERENCE BEIWEEN MEANS (ANGVA)	EEN )	GK INTER	ENUGE VS LINE [HIERACTION (ANOVA)	ova)	TEST	<b>∠</b> ⊢	
			ďF	I.E.	8	#	L	ಶ	2	8	
Alpha-1 Globulin	H8.H		£.58	6.50	84.	5,289	99.0	.63	1.21	.23	
Fraction	L		1,30	1.20	. 28	5,150	0.54	.74·	0.75	.45	
	X		1,26	0.03	98.	5,129	94.0	8.	1.19	.23	
	1484		1,54	0.50	84.	52,2781	0.44	96.	1.04	.32	
	u.		1,28	0.17	89.	52,1440	0.47	.99	-0.27	.79	
	æ		1,24	4.39	ф.	52,1237	9.64	86.	2.02	<b>,</b> 04	
A1-1- 0 01-1-1-1	1		ς,	5	ησ	789	96 U	77	5¶ U-	65	
Alpha-2 elebutin	L S L		, t	50.0	. 66	54.7	86.0		-0.11	) F.	
	. ¥			0.10	75	5,129	1.74	, 27	-0.09	.93	
	HV.		75	0.24	. 62	52.2781	0.74	, e)	-0.88	, , ,	
	<b>u</b> .		1,28	0.48	64.	52,1440	0.84	71.	-1.14	.25	
	Ι.		1,24	0.00	. 99.	52,1237	0.77	98.	0.02	.98	
Droubote Clobulin	14 14	6	٠ د د	i i	ą,	5 287	0.65	99	0.11	.91	
בותיים פוססים זונ	<u>.</u>	1 0	,	1 2/2	, ,	130	× × ×	67	0.67	. 6	
Fraction	L 3	7 6	2,50	יים יים יים	27.	100	88		-6.27	2,8	
	L (	4 (	7,1	100	, c	20.50	5 6	; 6	-0.57	57.	
	į.	7 (	+, ·	9 6		52,6/20	2,0	; ;	 	35	
	ı. :	7 (	07,1	0.0		72,1705	5 6	27.	7:51	7.	
	T.	7	1,24	÷2	<u>.</u>	52,1221	0.73	/0-	<1-I-	<b>+7</b> ·	
Beta Globulin	7.87		1.58	0.01	16.	5,289	0.54	.74	-0.10	.92	
Fraction	u		1,30	0.01	, ę.	5,150	0.87	.50	-0.45	.65	
	×:		1.26	0.09	.76	5,129	0.0	66.	0.50	.61	
	II.		1,54	0.19	99	52.2767	0.86	4.	1.16	.25	
	<b>L</b>		1,28	0.03	.93	52,1432	0.92	.63	0.47	.63	
	x		1,24	0.35	.56	52,1231	0.82	.78	60.0	-92	
100000	7	1-	č	6	8	289		č	0.26	79	
cioles celoi	<u>.</u>		0. 1 0. 1	0.08	35	5,149	1.96	60.	0.11	; 5;	
	. 3		2,7	0 05	3	5 130	1.53	. 00	00.0	. 6.	
	i u		- - - - -	7. O		52, 2797	0.51	66	0.75	74	
	Į IL		1,28	0.23	, ç	52,1450	0.48	66,	-0.22	.82	
	Œ	-	1,24	1.68	.21	52,1243	0.58	.99	46.0	.34	

Triglycerides M&F M M M M M M M M M M M M M M M M M M	13) F				(1110)	ואונא	ווון במשכון ומוו לאוו	(ANOVA)	153	
	18.F		dΕ	LL.	ಶ	ďF	ц.	ಶ	Z	8
			1,58	0.04	.22	5,28!	1.14	.34	-0.07	.94
	Ŀ		1,30	0.82	.37	5,144	0.18	.97	1.13	.26
	£		1,26	1.69	.21	5,127	1.28	.28	-1.28	.20
	43		1,54	2.32	.13	52,2781	0.59	99	1.63	. 10
	<b>LL</b> .		1,28	3.88	90.	52,1441	0.48	-99	1.57	.05
	×		1,24	0.01	.95	52,1236	0.65	8	0.48	.63
	181		1,58	1.10	.30	5,289	0.65	99.	-0.78	.43
	<b>L</b> L.		1,30	2.19	.15	5,150	99.0	.65	-1.54	.12
	r		1,26	0.18	.67	5,129	0.19	.97	0.45	.65
ž	isF		1,54	0.02	.87	52,2772	0.41	.99	0.22	.82
-	LL.		1,28	1.31	. 26	52,1440	09.0	.26	-1.09	.27
	<b>X</b> I		1,24	0.86	.36	52,1231	0.45	.99	1.56	.12
Pre-Beta Lipoprotein M&	143	<b>(</b>	1,58	0.00	99.	5,289	1.33	70.	-0.22	.82
	L		1,30	0.18	.67	5,150	1,20	.31	0.33	.73
•	E	•	1,26	44.0	.51	5,129	0,42	.83	-0.87	.38
ř	18F	_	1,54	0.11	- 74	52,2777	0.53	89.	-0.36	.72
	Ŀ	-	1,28	0.52	. 48	52,1440	0.78	88.	0.85	04.
-	T.	-	1,24	1.67	.21	52, 1233	0.53	8.	-1.21	.23
Beta Lipoprotein M8	13. 13.		1,58	2.11	.15	5,289	0.71	.61	1.39	91.
	Ŀ.		1,30	2.28	41.	5,150	1.02	.41	1.39	.16
	¥		1,26	0.12	.73	5,129	0.18	.97	0.73	94.
ž	ISF		1,54	0.30	.53	52,2777	0.71	÷5.	0.67	.50
	LL.		1,28	0.00	.97	52,1440	0.88	₩.	0.18	.85
_	T.		1,24	0.78	.38	52,1233	94.0	-99	0.00	ģ
Hematocrit M8	MSF		1,58	3.08	11.	5,287	44.0	.82	-0.11	16.
•	LL.		1,30	0.88	.35	5,149	29.0	<b>†9</b> *	-1.09	.27
•	I		1,26	0.38	.54	5,128	74.0	5/.	0.50	.61
¥ '	F.		1,54	0.11	.73	52,2798	0.31	ę. 29.	-0.24	∞.
3	ш. з		1,28	5.01	8,5	52, 1451	0.33	એ <u>લ</u>	-0.10	75
	ε		1,24	07.0	8.	54,1443	0.34	2	0.33	#/:

PARAMETER	SEX	TRANSFORMATION CODE*	9410	DIFFERENCE BETWEEN MEANS (ANOVA)	N.	SR	GROUP VS TIME INTERACTION (ANOVA)	E VAV	RANK	Y  -	
			дÞ	L	8	dF	u.	b	7	8	
Hemoglobin	75 12 14 14		1,58	0.20	.65	5,287	1.4.1	.22	-0.35	.72	
	. x		1,26	96.0	`	5, 128	79.0	.67	0,50	19	
	MEF		1,54	0.01	કુ	52,2799	0.52	8.	-0.41	.68	
	u.		1,28	0.16	٠.7	52,1451	0.77	-86	-0.31	.76	
	æ		1,24	0.62	74.	52,1244	94.0	86.	0.53	.59	
Mean Cell Volume	MEF		1,58	0.01	.30	5,287	0.33	<u>త</u> .	0.08	.93	
	ų.		1,30	0.05	.8.	5,149	0.16	86.	0,22	.82	
	æ		1,26	0.01	કું	5,128	0.59	.70	-0.23	.82	
	MEF		1,54	0.15	<u>.</u>	52,2799	0.54	-99	-0.36	.72	
	L		1,28	0.01	₽.	52,1451	0.42	98.	0.35	.72	
	¥		1,24	0.53	74.	52,1244	0.59	-99	-1.15	.24	
Mean Cell Hemoglobin	HS.F		1,58	0.15	.70	5.287	9.74	85.	-0.45	.65	
	14.		1,30	0.04	8	5,149	0.91	47	-0.41	89.	
	Æ		1,26	0.12	.73.	5,128	0.89	64.	-0.04	.96	
	MSF		1,54	1.25	.27	52,2798	0.54	.99	-0.98	.33	
	L		1,28	0.51	. 48	52,1451	C-48	.99	-0.47	.63	
	I		1,24	0.80	.38	52,1243	0.52	99	-1.31	.19	
Mean Cell Hemoglobin	MEF		1,58	0.27	.60	5,287	0.20	.96	-0.85	.39	
Concentration	<b>L</b> L.		1,30	0.39	.53	5,149	0.41	<b>78</b> .	-0.71	-47	
	X.		1,26	0.01	.92	5,128	0.32	.90	-0.41	.63	
	131		1,54	0.92	. <del>.</del>	52,2738	0.42	8,	-1.39	.16	
	ш,		1,28	2.27	14	52,1451	0.47	99.	-1.59	Ξ.	
	Σ		1,24	0.05	8.	52,1243	0.43	<u>ę.</u>	-0.43	.72	
Red Blood Cell Count	MEF		1,53	0.03	÷8.	5,287	0.67	<del>1</del> 9.	-0.23	8.	
	ᄔᇸ		 	0.93	ž:	5,149	1.09	.37	-0.90 9.00	.37	
	E 1		1,25	0.70	4.	5,128	0.1/		0.59	ý,	
			1,28	0.50	<b>.</b> £	52, 1451	0.34	۲. و و	0.35	27	
	Œ		1,24	1.44	.23	52,1244	0.32	ġ	1.01	.31	

PARAMETER	SEX	TRANSFORMATION CODE*	910	DIFFERENCE BETWEEN MEANS (ANOVA)	EEN )	GR	GROUP VS TIME	TIME (ANOVA)	RANK	
			дЪ	L	ಶ	dF	L	ಶ	Z	p
White Blood Cell	MSF		1,58	0.00	.97	5,287	0.27	.93	-9.08	.93
Count	L.		1,30	0.38	.54	5,149	0.72	09.	0.18	.85
	¥	<b></b>	1,26	0.75	<del>ن</del> چ	5,128	0,13	.98	-0.09 -0.09	.93
	ii Xe X	<b>pa.</b>	1,54	0.11	- 74	52,2799	0.87	. 72	90.0-	.95
	LL :	<b>,</b>	1,28	0.27	క్స్ :	52,1451	0.97	<u>ښ</u>	0.47	.63
	æ	_	1,24	1.08	.33	52,1244	0.76	92.	-0.82	. 40
Lymphocytes	M.S.F		1,58	0.00	66.	5,285	0.64	99.	0.47	·64
	LL.		1,30	0.10	.74	5,148	0.79	.56	-0.03	.97
	æ		1,26	0.13	.72	5,127	0.52	11.	0.68	64.
	T.		1,54	0.01	£.	52,2795	0.82	.81	0.55	.57
	اس:		1,28	0.97	æ:	52,1449	0.66	.97	-0.72	.47
	Σ		1,24	0.52	<b>#</b> 47.	52, 1242	1.05	%	0.17	<b>†</b> †.
Monocytes	MS.F								-0.10	.92
	اد ع								0.00	e. 8
	78.F								-0.24	ું હ
	ıL								0.06	.95
	E								-0.19	.85
Polyneutrophiles	785		1,58	0.02	.87	5,285	0.74	.59	-0.29	.17
	<b>L</b> L		1,30	0.32	.57	5,148	1.01	14.	0.37	.71
	<b>x</b> :		1,26	0.14	2.5	5,127	0.40	₩. -	<del>1</del> 9.0-	.52
	الم الخ عد		1,54	0.03	بن بي رو	52,2796	0.83 6.83	.82	-0.34	£.
	<b>.</b> :		1,28	69.1	.38	52,1449	0.80	*×.	0.80	. 42
	×		1,24	0.42	.52	52,1243	0-98	-50	-1.26	.21
Eosinophiles	K.								-1.28	.20
	Œ								-1.13	.26
	æ								-0.68	64.
	i i								-0.54	قرار
	L 3								0.0°	÷.
									t C - O -	٠,

PARAMETER	SEX	TRANSFORMATION CODE*	910	DIFFERENCE BETWEEN MEANS (ANOVA)	IEEN ()	GP INTER	GROUP VS TIME INTERACTION (ANO	TIME (ANOVA)	RANK	<b>⊻</b> ⊢
			d.	lu.	8	ďF	L	8	7	ಶ
Basophi Jes	HEF								-1.86	90.
	L.								-1.99	.05
	X.								-0.78	.43
	NSF F								0.21	<u>ښ</u>
	u.								0.43	99.
	Æ								-0.23	25
Bands	¥8.								0.19	.85
	L.								0.22	.82
	Æ								<b>0.0</b>	8
	H.S.F.								0.16	.87
	łа.								1.18	. 24
	I								-0.97	.33
Sodium	L d		87.	74 0	57	788	0 43	83	0.23	oc.
	<u>u</u> .		1,30	1.08	) F.	5,149	0.42	.83	0.71	747
	Σ		1.26	0.00	66	5,129	09.0	7.0	-0.45	.65
	MSF		1.54	1,45	.23	52,2800	0.71	46.	1.03	.32
	u.		1,28	0.14	.77	52,1451	3.62	66.	0.22	.82
	æ		1,24	2.52	. 12	52,1245	92.0	98.	1.71	60.
Počassium	14. 14.	<b>,-</b>	1.58	1.62	.21	5.288	0.62	89.	1.67	60.
	u.	-	1.30	0.08	. 78	5,140	0.53	.75	0.67	20.
	x	_	1.26	3.70	-07	5,129	04.0	84	2.02	40.
	M&F	-	1,54	1.43	. 24	52,2800	0,62	46.	0.98	.33
	LL.	_	1,28	0.13	.70	52,1451	0.89	.72	0.10	. 55
	x		1,24	3.68	-03	52,1245	0.86	.74	1.76	.08
7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7	<u>د</u> ا ۱۷		ă L	ŭ	"	787	0.47	5	11 25	21
	<u>.</u>		30,7		77.	5,148	1.55		-0.82	1-5
	Σ		1.26	0,13	.72	5,129	0.24	66.	-0.64	.52
	MSF		1 24	0.00	કે,	52,2794	1.06	.33	0.08	2.
	LL		1,28	1.48	.23	52,1448	0.72	88.	-1.18	. 12
	æ		1,24	1.97	.17	52,1242	1.43	.02	1.41	.15

Galcium HeF 1,58 0.49 .48 5,287 0.52 .76 0.73 .46 1,158 0.49 .48 5,287 0.52 .76 0.73 .46 1,158 0.49 .48 5,287 0.52 .76 0.73 .46 1,158 0.49 1,146 1,27 5,129 0.46 .80 4.87 .34 1,16 0.07 34 1,16 0.07 34 1,16 0.07 34 1,16 0.07 34 1,16 0.07 34 1,16 0.07 34 1,19 1,19 1,19 1,19 1,19 1,19 1,19 1,1	PARAMETER	SEX	TRANSFORMATION CODE*	1910 H	DIFFERENCE BETWEEN MEANS (ANOVA)	WEEN A)	GR INTER	GROUP VS TIME (INTERACTION (ANOVA)	E OVA)	RANK	X F
MEF         1,58         0.49         .48         5,287         0.52         .76         -0.73           H         1,30         0.49         .48         5,287         0.52         .76         -0.73           HE         1,36         0.30         .39         5,148         1.66         .04         -0.87           HE         1,24         1.46         .23         52,1749         1.04         .38         -0.89           HE         1,24         0.05         .82         52,1749         1.07         .34         1.76           HE         1,28         7.82         .0.6         .39         1.34         1.76         .0.95           HE         1,24         0.05         .20         5,129         0.74         .39         .1.76           HE         1,24         0.19         .46         <0.001				늄	u.	ð	#b	ĭĿ	೮	Z	В
F   1,30   0,30   .99   5,148   1,60   .04   .0.07     F   1,28   3.25   .08   52,1797   1,19   .17   0,19     F   1,28   3.25   .08   52,1746   1,07   .34   1,76     F   1,28   3.25   .08   52,1747   1,19   .17   0,19     H   1,24   0,05   .82   .20   5,150   0,14   .39   -1,41     H   1,26   0,16   .20   5,150   0,17   .57   1,09     H   2   1,26   0,16   .001   5,129   1,34   .24   .22     H   2   1,24   0,01   .91   5,290   1,09   .36   .20     H   2   1,28   5.07   .03   5,120   0,20   .37   .27     H   2   1,28   0,01   .39   52,1748   0,10   .34   0,43     H   2   1,28   0,00   .97   52,1446   0,18   .37   0,43     H   1   1,26   0,29   .32   5,130   0,18   .37   0,14     H   1   1,26   0,13   .71   5,149   1,61   1,11   1,51     H   1   1,26   0,29   .32   5,289   1,34   .39   .0.5     H   1   1,26   0,29   .32   5,289   1,34   .39   .0.5     H   1   1,26   0,29   .32   5,130   0,18   .37   0,25     H   1   1,26   0,29   .32   5,146   0,20   .34   .39   .0.5     H   1   1,26   0,29   .32   .24   .39   .30   .34   .37   .35     H   1   1,26   0,29   .32   .24   .39   .30   .34   .39   .0.5     H   1   1,26   0,29   .32   .24   .39   .30   .34   .39   .0.5     H   1   1,26   0,29   .32   .24   .39   .30   .34   .39   .0.5     H   1   1,26   0,29   .32   .24   .39   .30   .34   .39   .0.5     H   1   1,26   0,39   .32   .24   .39   .30   .34   .39   .0.5     H   1   1,26   0,39   .32   .24   .39   .30   .34   .39   .0.5     H   1   1,26   0,39   .32   .24   .39   .30   .30   .30   .30     H   1   1,26   0,39   .32   .24   .39   .30   .30   .30   .30     H   1   1,26   0,39   .32   .32   .39   .30   .30   .30   .30   .30     H   1   1,26   0,39   .32   .32   .39   .30   .30   .30   .30   .30   .30     H   1   1,26   0,30   .33   .30	Calcium	MSF		1,58	0.49	84.	5,287	0.52	.76	-0.73	94.
H 1, 26 0.83 .37 5,129 0.46 .80 -0.87   H 1, 24 1, 146 .23 5,1249 1.19 .17 0.95   H 1, 24 0.05 .82 5,1249 1.19 .17 0.95   H 1, 28 3.25 .88 52,1245 0.64 .98 -0.44   H 1, 28 7.82 .01 5,289 1.34 .24 1.76   H 1, 20 9.46 0.001 5,129 1.06 .39 2.25   H 1, 24 0.19 0.66 52,1794 0.65 .37 0.04   H 1, 24 0.19 0.61 5,129 1.06 .39 0.04   H 2 1, 26 0.01 5,129 1.06 .39 0.04   H 2 1, 26 0.01 5,129 1.06 .39 0.04   H 2 1, 26 0.01 5,130 0.13 0.04   H 2 1, 26 0.01 5,130 0.10 0.10 0.18   H 2 1, 26 0.00 0.13 5,130 0.16 0.19   H 2 1, 24 0.07 0.19 5,130 0.16 0.19   H 2 1, 24 0.07 0.19 5,146 0.80 0.84 0.56   H 2 1, 26 0.00 0.19 5,1240 0.18 0.19   H 2 1, 24 0.03 0.13 5,1240 0.18 0.10   H 2 1, 24 0.03 0.13 5,1240 0.18 0.18   H 3 1 1, 24 0.03 0.13 5,124 0.18 0.18   H 4 1 1, 24 0.03 0.13 5,124 0.18 0.18   H 5 1, 24 0.03 0.13 5,124 0.18 0.18   H 1, 24 0.03 0.18 0.18 0.18   H 1, 25 0.18 0.18 0.18   H 1, 25 0.18 0.18 0.18   H 1, 25 0.18 0.18 0.18   H 1, 26 0.18 0.18 0.18   H 1, 27 0.18 0.18   H 1, 28 0.18 0.18   H 1, 29 0.18 0.18   H 1, 20 0.18 0.18 0.18   H 1, 20 0.		ш.		1,30	G. 90	ક્	5,148	1.60	<b>.</b> 04	0.07	₹.
REF         1,54         1,46         23         52,2797         1,19         .17         0,59           F         1,28         3,25         .08         52,1448         1,07         .34         .176           MEF         1,28         3,25         .08         52,1448         1,07         .34         .04           F         1,28         7,82         .01         5,289         1,34         .04         .0         .0           H         1,26         9,46         <0.01         5,130         0.77         .57         1.09           H         1,26         0.13         .158         0.01         .93         52,134         0.65         .39         0.73           H         1,28         0.01         .93         52,1448         0.73         .92         .0         .93         .0         .93         .0		x		1,26	0.83	.37	5,129	94.0	· 80	-0.87	.38
F   1,28   3.25   .08   52,1448   1.07   .34   1.76     He   1,29   0.05   .82   52,1245   0.64   .98   -0.43     H   1,20   1.68   .20   5,139   1.34   .24   .2.24     He   1,24   0.19   .66   52,1794   0.65   .97   0.08     He   2   1,28   0.01   .93   .2.2794   0.65   .97   0.08     He   2   1,28   0.01   .93   .26   .97   0.43     He   2   1,26   0.03   .95   .90   0.22   .95   0.47     He   2   1,26   0.03   .97   .97   .95   .95   0.47     He   2   1,24   0.72   .97   .97   .97   .97   .97     He   1   1,24   0.03   .97   .97   .97   .97   .97     He   1   1,24   0.03   .97   .97   .97   .97   .97     He   1   1,24   0.03   .97   .97   .97   .97   .97     He   1   1,24   0.03   .97   .97   .97   .97   .97     He   1   1,24   0.03   .97   .97   .97   .97   .97     He   1   1,24   0.03   .97   .97   .97   .97     He   1   1,24   .97   .97   .97   .97   .97   .97     He   1   1,24   .97   .97   .97   .97   .97   .97   .97     He   1   1,24   .97		MSF		1,54	1.46	.23	52,2797	1.19	.17	0.95	.34
Michael   Mich		u.		1,28	3.25	89.	52,1448	1.07	.34	1.76	80.
HE         1,58         7.82         .01         5,289         1.34         .24         2.04           H.         1,30         1.68         .20         5,150         0.77         .57         1.09           H.         1,24         0.19         .26         5,150         0.77         .57         1.09           H.         1,24         0.19         .26         5,150         0.73         .27         0.08           H.         2         1,24         0.19         .33         52,1244         0.65         .37         0.78           H.         2         1,24         0.43         .51         22,1244         0.73         .22         1.44         0.73         .52,1242         0.80         .84         0.73         0.74           H.         2         1,54         0.72         .39         52,1240         0.76         .35         .27,239         0.81         .20         .14           H.         2         1,54         0.72         .39         52,1240         1.24         0.75         .39         .27,239         0.81         .20         .20           H.         1         1,54         0.72         .39         .22		x		1,24	0.05	.82	52,1245	p. 64	.58	-0.43	.72
H.         1,30         1,68         .20         5,150         0.77         .57         1.00           H.         1,26         9.46         <0,001         5,159         0.77         .57         1.00           F         1,26         9.46         <0,001         5,129         0.65         .39         0.22           NGF         2         1,24         0.43         .51         52,1242         0.65         .97         0.08           NGF         2         1,58         0.01         .93         52,1242         0.80         .84         0.043           H         2         1,58         0.01         .93         52,1242         0.80         .84         0.043           H         2         1,36         0.72         .93         52,1242         0.80         .34         0.43           H         2         1,36         0.72         .93         52,1246         0.80         .34         0.73           H         2         1,36         0.72         .93         52,1246         0.80         .34         0.75           H         2         1,24         0.72         .33         52,1246         0.80         .34	Second Glutamic	H&F		1.58	7.82	.01	5.289	1.34	.24	2.24	.02
H. H	Oxaloacetic	L.		1,30	1.68	. 20	5,150	0.77	.57	1.09	.27
HEF         1,54         0.19         .66         52,2794         0.65         .97         0.08           F         1,28         0.01         .93         52,1448         0.73         .92         -0.76           H         1,24         0.43         .51         52,1242         0.80         .84         -0.76           H         2         1,36         5.07         .03         5,290         1.09         .36         -0.76           HSF         2         1,56         0.72         .39         52,2790         0.81         .82         0.73           HSF         2         1,54         0.72         .39         52,1746         0.80         .84         -0.56           F         1         1,24         2.33         .14         52,1246         0.80         .84         -0.56           H         1         1,24         2.33         .14         52,1246         0.14         .11         1.47           HSF         1         1,24         2.33         .14         52,1246         0.18         .37         1.21           HSF         1         1,24         0.73         .25         .28         .14         .39	Transaminase	*		1,26	9,46	<0.001	5,129	1.06	.39	2.25	.02
F         1,28         0.01         .93         52,1448         0.73         .92         -0.76           MSF         2         1,24         0.43         .51         52,1242         0.80         .84         0.43           MSF         2         1,24         0.43         .51         52,1242         0.80         .84         0.43           F         2         1,26         5.07         .03         5,290         1.09         .36         2.17           HSF         2         1,26         5.08         .03         5,130         1.76         .12         1.47           HSF         1,24         0.72         .39         52,1240         1.76         .12         1.97           HSF         1         1,24         2.33         .14         52,1240         1.24         .11         1.51           HSF         1         1,24         2.33         .14         52,1240         1.24         .15         1.24         .15         1.24         .15         1.24         .15         1.24         .15         .15         .15         .15         .15         .15         .15         .15         .15         .15         .15         .15		H SK		1,54	0.19	.66	52,2794	0.65	.97	0.08	.93
NGF         2         1,24         0.43         .51         52,1242         0.80         .84         0.43           F         2         1,58         5.07         .03         5,1290         1.09         .36         2.17           H         2         1,26         5.08         .03         5,130         1.76         .12         1.97           HSF         2         1,26         5.08         .03         5,130         1.76         .12         1.97           F         2         1,26         5.08         .03         5,130         1.76         .12         1.97           HSF         2         1,26         0.72         .39         52,1240         0.81         .82         0.78           F         1         1,24         0.03         .32         52,1240         1.24         1.51           HSF         1         1,54         0.23         .32         5,149         1.61         .151         1.51           HSF         1         1,54         0.23         .63         52,1245         0.34         .99         -0.37           HSF         1         1,24         0.03         .93         52,1245         0.3		u.		1,28	0.01	.93	52,1448	0.73	.92	-0.76	44.
NSF         2         1,58         5.07         .03         5,290         1.09         .36         2.17           F         2         1,26         5.08         .03         5,130         1.76         .12         1.47           HSF         2         1,26         5.08         .03         5,130         1.76         .12         1.97           HSF         2         1,26         0.72         .39         52,2790         0.81         .82         0.78           HSF         1         1,24         2.33         .14         52,1240         1.24         .11         1.51           HSF         1         1,26         0.73         .32         5,289         1.06         .15         1.51           HSF         1         1,26         1.37         .25         5,149         1.61         .16         .16         .16         .16         .15           HSF         1         1,26         0.23         .63         52,1249         0.34         .99         -0.37           HSF         1         1,24         0.03         .39         52,1245         0.39         .99         -0.76           HSF         1         1,24<		x		1,24	0.43	.51	52,1242	0.80	₹8,	0.43	99.
F         2         1,30         1.33         .26         5,150         0.22         .95         1.47           HSF         2         1,26         5.08         .03         5,130         1.76         .12         1.97           HSF         2         1,26         0.72         .39         55,1790         0.81         .82         0.78           F         1         2         1,24         2.33         .14         52,1240         1.24         .13         0.56           F         1         1,24         2.33         .14         52,1240         1.24         .11         1.51           HSF         1         1,26         0.33         .32         5,285         1.08         .37         1.51           HSF         1         1,26         0.13         .71         5,149         1.6i         .16         .15           HSF         1         1,24         0.03         .23         52,1245         0.39         .93         0.34         .99         -0.76           HSF         1         1,24         0.03         .93         52,1245         0.39         .99         -0.76           HSF         1         1,24 <td>erum Glutamic</td> <td>MSF</td> <td>2</td> <td>1,58</td> <td>5.07</td> <td>.03</td> <td>5,290</td> <td>1.09</td> <td>.36</td> <td>2.17</td> <td></td>	erum Glutamic	MSF	2	1,58	5.07	.03	5,290	1.09	.36	2.17	
HEF         2         1,26         5.08         .03         5,130         1.76         .12         1.97           HEF         2         1,54         0.72         .39         52,2790         0.81         .82         0.78           F         2         1,54         0.72         .39         52,2790         0.81         .84         -0.56           H         1         1,24         2.33         .14         52,1240         1.24         .11         1.51           H         1         1,58         0.99         .32         5,289         1.08         .37         1.51           H         1         1,26         0.13         .71         5,149         1.61         .15         0.56           F         1         1,26         0.73         .25         5,130         0.18         .97         1.51           H         1         1,24         0.23         .63         52,1745         0.34         .99         -0.76           H         1         1,26         0.76         .39         52,1448         0.26         .99         -0.76           H         1         1,24         0.03         .93         52,1245	Pyruvic	<b>L</b> .	2	1,30	1.33	. 26	5,150	0.22	.95	1.47	
HGF         2         1,54         0.72         .39         52,2790         0.81         .82         0.78           F         2         1,28         0.00         .97         52,1446         0.80         .84         -0.56           HGF         1,24         2.33         .14         52,1240         1.24         .151           HGF         1         1,58         0.29         .32         5,285         1.08         .37         1.21           HGF         1         1,30         0.13         .71         5,149         1.61         .16         0.56           HGF         1         1,26         1.37         .25         5,130         0.18         .97         1.51           H         1         1,24         0.23         .63         52,2797         0.34         .99         -0.76           HGF         1         1,24         0.03         .93         52,1245         0.39         .99         0.20           HGF         1         1,24         0.03         .93         52,1245         0.39         .99         0.06           HGF         1         1         1         1         1         0         0	Transaminase	TC.	7	1,26	5.08	.03	5,130	1.76	.12	1.97	
F       2       1,28       0.00       .97       52,1446       0.80       .84       -0.56         HSF       1,24       2.33       .14       52,1240       1.24       .11       1.51         HSF       1       1,58       0.99       .32       5,285       1.08       .37       1.21         HSF       1       1,26       0.13       .71       5,149       1.6i       .16       0.56         HSF       1       1,26       0.13       .71       5,149       1.6i       .16       0.56         F       1       1,26       0.13       .71       5,149       1.6i       .16       0.56         F       1       1,26       0.23       .63       52,1797       0.34       .99       -0.76         HSF       1       1,24       0.03       .93       52,1448       0.26       .99       -0.76         HSF       H       1       1,24       0.03       .93       .93       .93       0.20         HSF       H       H       H       H       H       H       H       H       H       H       H       H       H       H       H       H		MSF	7	1,54	0.72	.33	52,2790	0.81	<b>.8</b> 2	0.78	
HSF       1,24       2.33       .14       52,1240       1.24       .11       1.51         HSF       1       1,58       0.59       .32       5,285       1.08       .37       1.21         H       1       1,26       1.37       .25       5,149       1.6i       .16       0.56         HSF       1       1,26       1.37       .25       5,130       0.18       .97       1.51         F       1       1,28       0.23       .63       52,2797       0.34       .99       -0.37         HSF       1       1,24       0.03       .93       52,1448       0.26       .99       -0.76         H       1       1,24       0.03       .93       0.39       .99       -0.23         H       H       1       1,24       0.03       .93       .52,1245       0.39       .99       0.09         H <td></td> <td>ta.</td> <td>2</td> <td>1,28</td> <td>0.00</td> <td>.97</td> <td>52,1446</td> <td>0.80</td> <td>78.</td> <td>-0.56</td> <td></td>		ta.	2	1,28	0.00	.97	52,1446	0.80	78.	-0.56	
HSF         1         1,58         0.99         .32         5,285         1.08         .37         1.21           F         1         1,30         0.13         .71         5,149         1.6i         .16         .16         0.56           H         1         1,26         1,37         .25         5,130         0.18         .97         1.51           HSF         1         1,54         0.23         .63         52,2797         0.34         .99         -0.37           H         1         1,28         0.76         .39         52,1448         0.26         .99         -0.76           H         1         1,24         0.03         .93         52,1245         0.39         .99         -0.76           H         1         1,24         0.03         .93         .99         -0.76           H         1         1,24         0.03         .93         .99         .99           H         1         1,24         0.03         .93         .99         .99           H         1         1         1         1         1         1         1           H         1         1         1		X.	2	1,24	2.33	14	52,1240	1.24	=	1.51	
F       1       1,30       0.13       .71       5,149       1.6i       .16       0.56         H       1       1,26       1.37       .25       5,130       0.18       .97       1.51         HSF       1       1,54       0.23       .63       52,2797       0.34       .99       -0.37         F       1       1,28       0.76       .39       52,1448       0.26       .99       -0.76         H       1       1,24       0.03       .93       52,1245       0.39       .99       -0.76         F       H       1       1,24       0.03       .93       52,1245       0.039       .99       0.03         H       H       1       1,24       0.03       .93       .99       .09       0.09         H       1       1,24       0.03       .93       .52,1245       0.39       .99       0.09         H       1       1,24       0.03       .93       52,1245       0.03       .99       0.09         H       1       1       0.03       0.03       0.03       0.00       0.00         H       1       0       0.03       0.03	Lactate	MSF	<b>74.</b> **	1,58	0.99	.32	5,285	1.08	.37	1.21	.23
H 1, 26 1.37 .25 5,130 0.18 .97 1.51 1,54 0.23 .63 52,2797 0.34 .99 -0.37 1,28 0.76 .39 52,1797 0.34 .99 -0.76 1,28 0.76 .39 52,1448 0.26 .99 -0.76 1,24 0.03 .93 52,1245 0.39 .99 0.23 H&F F F F F F F F F F F F F F F F F F F	ehydrogenase	LL.	-	1,30	0.13	.71	5,149	1.6i	91.	0.56	.57
MSF     1     1,54     0.23     .63     52,2797     0.34     .99     -0.37       F     1     1,28     0.76     .39     52,1448     0.26     .99     -0.76       MSF     1,24     0.03     .93     52,1245     0.39     .99     0.23       MSF     NSF     1,24     0.03     .93     52,1245     0.39     .99     0.23       MSF     NSF     NSF     1.40     0.90       M     0.002	,	X.	-	1,26	1.37	.25	5,130	0.18	.97	1.51	.13
F 1 1,28 0.76 .39 52,1448 0.26 .99 -0.76  H 1,24 0.03 .93 52,1245 0.39 .95 0.23  HEF 7 1,24 0.03 .93 52,1245 0.39 .99 0.23  H 1,24 0.03 .93 52,1245 0.39 .99 0.23  H 1,24 0.03 .93 52,1245 0.39 .99 0.23		MSF	-	1,54	0.23	.63	52,2797	0.34	£.	-0.37	.70
H 1,24 0.03 .93 52,1245 0.39 .99 0.23  HEF F O.90 H NEF F H NEF H H O.002		L	_	1,28	9.76	65,	52,1448	0.26	.99	-0.76	74.
H&F F N M M MSF MSF MSF MSF MSF MSF MSF MSF MSF		x	çun	1,24	0.03	85	52, 1245	0.39	.93	0.23	.77
2.02 0.65 1.26 0.02	Creatine hosphokinase	H. Fr								1.40	.16
0.02		* # # # # # # # # # # # # # # # # # # #								2.02 0.65 1.26	\$ <i>12</i> 8
		L XI								0.02	8.

PARAMETER	SEX	TRANSFORMATION CODE*	H H	FFERENCE BETWEEN MEANS (ANOVA)	EEM )	GR( INTER/	GROUP VS TIME INTERACTION (ANOVA)	VA)	RANK	× -	j
			đΕ	LL.	ಶ	dF	ш.	ਰ	. 14	ರ	
Gamma~Glutamy]	¥8.F		1,58	1.38	.24	5,285	4/-0	62.	1.37	.17	
Transpeptidase	LI		5,7	0.82	, . ,	5,125	0.51	.76 .76	1.42	. <del>.</del> 5.	
	ASF		1,54	2.96	, e.	52,2797	0.53	96.	1.27	. 20	
	u.		1,28	0.84	.37	52,1447	0.91	·64	49.0	.53	
	X		1,24	3.95	90.	52,1246	0.49	-33	1.92	96.	
Phosphohexos	MSF		1,58	1.45	.23	5,289	1.28	.27	1.24	.21	
Somerase	LL.		1,30	0.32	75.	5,150	0.71	.61	97.56	.75	
	X.	,	1,26	1.42	.24	5,129	0.76	.58	1.33	. 18	
	MSF	-	1,54	0.01	<u>e.</u>	52,2802	0.49	.99	-0.21	.76	
	u.	-	1,28	G. 04	.83	52,1452	0.34	-99	-0.39	69.	
	£	,	1,24	0.01	.95	52,1246	0.56	.99	0.33	.73	
Glucose	13 H		1,58	1.63	.21	5.288	0.94	.45	1.09	.27	
	ш		1,30	6.05	. 82	5,149	1.05	.33	-0.22	.82	
	æ		1,26	3.52	.07	5,129	0.89	.55	1.83	.07	
	ASF		1,54	4.11	.05	52,2789	1.01	44.	1.62	. 10	
	ш		1,28	0.13	.71	52,1445	0.84	.77	0.14	88.	
	x		1,24	7.01	.01	52,1240	 6)	.21	2.07	ţ0.	
Blood Urea	# 5		1,58	1.01	.32	5,290	0.46	8.	1.13	.26	
Nitregen	LL.		1,50	0.25	.62	5,150	0.41	.84	0.41	89.	
)	Œ		1,26	0.86	.36	5,130	0.51	.77	1.19	.23	
	MEF		1,54	0.17	.67	52,2799	0.64	86.	0.03	94.	
	LL.		1,28	1.61	.21	52,1451	0.57	<u>ي</u> وي	-1.39	.16	
	æ		1,24	4.17	.05	52,1244	0.73	. 83	1.92	90.	
T	i,										
iri iodi tiiyroniile											
	æ										
	₩8F	-4	1,54	0.22	·64	38,1970	0.71	.91	-0.34	.73	
	u.	-ੜ <b>ਾ</b>	1,28	2.53	. 12	38, 1021	0.72	8.	-0-85	9.50	
	<b>3</b> .,	<b>†</b>	1,24	0.42	. 52	38,873	0.45	٠. وي	0.28	./s	

Tetralodithyronine	PARAMETÉR	SEX	TRANSFORMATION CODE*	DIF.	DIFFERENCE BETWEEN MEANS (ANOVA)	VEEN ()	GR INTER	GROUP VS TI	TIME (ANOVA)	RANK	높 i	
H KF H T T T T T T T T T T T T T T T T T T				dF	LL.	ಶ	ΑF	ш	ಶ	2	ಶ	
High High High High High High High High	Tetraiodithyronine	E S E										
F         1,28         0.04         .84         36,1022         0.75         .85         -0.10           MEF         1,24         0.40         .53         38,868         0.46         .99         1.35           H         H         1,54         0.40         .53         38,1952         0.75         .98         -0.10           H         1,24         0.34         .56         38,1952         0.57         .98         0.88           H         1,24         0.34         .56         38,863         0.40         .39         0.88           H         1,24         3.11         .09         38,863         0.40         .39         0.56           H         1,24         0.37         .62         52,2661         0.46         .39         1.9           H         1,24         0.37         .62         52,1371         .04         .39         -0.29           H         1,24         1.31         .26         52,1371         0.40         .99         -0.29           H         1,24         0.03         .36         .07         52,1371         0.60         .98         -0.29           H         1,54         0.03		E SE		1.54	0.32	.57	38 1966	0.57	8	0 73	1,1	
HEF       1,24       0.40       .53       38,868       0.46       .99       1.35         HEF       1,54       0.34       .56       38,1952       0.57       .98       0.88         HEF       1,24       3.11       .09       38,863       0.40       .99       1.35         HEF       1,24       3.11       .09       38,863       0.40       .39       1.39         HEF       1,24       3.11       .09       38,863       0.40       .39       1.39         HEF       1,24       0.37       .62       52,2661       0.46       .39       1.39         HEF       1,24       0.37       .62       52,2661       0.46       .39       -0.39         HEF       1,24       1.31       .26       52,1186       3.37       <0.0001       -0.39         HEF       1,24       0.03       .25       1371       0.64       .98       -0.29         HEF       1,54       0.03       22,1361       0.47       .91       -0.29         HEF       1,54       0.03       22,1361       0.45       <0.001       -1.92         HEF       1,54       0.01       .93       5		Œ		1,28	0.04	έφ.	38,1022	0.78	2,80	-0.10	÷6	
HGF         HGF         1,54         0.34         .56         38,1952         0.57         .98         0.88           H         1,24         0.34         .56         38,1952         0.57         .98         0.88           H         1,24         3.11         .09         38,865         0.40         .39         1.91           H         1,24         3.11         .09         38,865         0.40         .39         1.91           H         1,54         0.37         .62         52,2661         0.46         .39         -0.39           H         1,24         1.31         .26         52,1371         1.03         .40         0.18           H         1,24         0.01         .94         52,1371         1.03         .40         -0.89           H         1,24         0.03         .99         52,2661         0.47         .91         -0.29           H         1,28         1.16         .21         22,1371         0.60         .98         1.26           H         1,24         0.03         .99         52,1661         0.47         -91         -1.92           H         1,24         0.01         .99 </td <td></td> <td>Σ</td> <td></td> <td>1,24</td> <td>0.40</td> <td>.53</td> <td>38,868</td> <td>97.0</td> <td>66,</td> <td>1.35</td> <td></td> <td></td>		Σ		1,24	0.40	.53	38,868	97.0	66,	1.35		
F       1,54       0.34       .56       38,1952       0.57       .98       0.88         F       1,24       3.11       .09       38,1013       0.85         -0.51         H6F       1,24       3.11       .09       38,862       0.46       .39       1.9;         F       1,54       0.37       .62       52,2661       0.46       .99       -0.39         H6F       1,54       0.37       .62       52,1361       0.46       .99       -0.39         H6F       1,24       1.31       .26       52,1186       3.37       <0.001       -0.89         H6F       1,54       0.01       .29       52,2661       0.47       .91       -0.29         F       1,54       0.03       .99       52,2661       0.47       .91       -0.29         H7       1,24       3.66       .07       52,1186       6.45       <0.001       -1.92         H8F       1,54       0.01       .93       51,2581       1.81       -0.03       -0.21         H8F       1,24       0.05       .42       51,1357       1.30       -0.001       -1.92         H8F <t< td=""><td>Thyro d Index</td><td>HEF</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	Thyro d Index	HEF										
HéF 1,54 0.34 .56 38,1952 0.57 .98 0.88 1.29 1.29 1.59 1.29 1.59 1.24 3.11 .09 38,862 0.40 .39 1.59 1.59 1.59 1.59 1.59 1.59 1.59 1.5		<b>u.</b> ;										
1,54   0.34   .56   38,1952   0.57   .98   0.88   1.95		Σ .		į	,		,					
HEF F H H H H H H H H H H H H H H H H H		₽ L		1,54	0.34	.56	38,1952	0.57	86.	0.88	<u>.</u> 6	
HEF F H H H H H H H H H H H H H H H H H		Σ		1,24	3.11		38,863	0.40	. <del>.</del> 96.	ا برنی	š. ?.	
HEF HRF HRF HRF HRF HRF HRF HRF HRF HRF HR	Sody We oht	L S										
Hately Ha	7 f	<u>.</u>										
HSF		Σ										
HSF HSF HSF HSF HSF HSF HSF HSF		<b>-</b> -		1,54	0.37	.62	52,2661	0.46	-99	-0.39	69.	
M8:         F       1,54       6.03       .99       52,2661       0 47       .91       -0.29         F       1,28       1.16       .21       52,1371       0.60       .98       1.26         H       1,24       3.66       .07       52,1186       6.45       <0.001				1,28 1,24	0.01	¥ %	52,1371	1.03	04.	0.18	56.	
ME:       F       1,54       0.03       .99       52,2661       0 47       .91       -0.29         MEF       1,28       1.16       .21       52,1371       0.60       .98       1.26         1,24       3.66       .07       52,1186       6.45       <0.001						2	72,1100	10.0	100.07	-0.03	٠:٠	
HEF 1,54 0.03 .99 52,2661 0.47 .91 -0.29 1.26 1.26 1.26 .98 1.26 1.24 1.24 1.16 .21 52,1371 0.60 .98 1.26 1.26 1.24 1.54 0.07 52,1186 6.45 <0.001 -1.92 1.92 HEF 1,54 0.01 .93 51,2581 1.81 .003 -0.21 F 1,28 0.35 .55 51,1122 1.78 <0.001 -0.84	ody Weight Ratio	MET										
MEF         1,54         0.03         .99         52,2661         0 47         .91         -0.29           F         1,28         1.16         .21         52,1371         0.60         .98         1.26           HSF         3.66         .07         52,1186         6.45         <0.001		LΣ										
F 1,28 1.16 .21 52,1371 0.66 .98 1.26		: ¥		1 54	0 03	8	1776 63	7,7	č	0	Ç	
HRF		u.		1,28	1.16	3.5	52,2651	) (c	, 8	-0.29	9,5	
H8F H H8F 1,54 0.01 .93 51,2581 1.81 .003 -0.21 1,28 0.35 .55 51,1357 1.30 .08 0.64 H 1,24 0.65 .42 51,1122 1.78 <0.0010.84		Σ		,24	3.66	.07	52,1186	6.45	0.00	-1.92	.05	
F HSF 1,54 0.01 .93 51,2581 1.81 .003 -0.21 F 1,28 0.35 .55 51,1357 1.30 .08 0.64 H. 1,24 0.65 .42 51,1122 1.78 <0.001 .0.84	Xygen Consumption	MSF										
1,54 0.01 .93 51,2581 1.81 .003 -0.21 1,28 0.35 .55 51,1357 1.30 .08 0.64 1,24 0.65 .42 51,1122 1.78 <0.0010.84		ıL										
1,54 0.01 .93 51,2581 1.81 .003 -0.21 1,28 0.35 .55 51,1357 1.30 .08 0.64 1,24 0.65 .42 51,1122 1.78 <0.0010.84		×										
1,28 0.35 .55 51,1357 1.30 .08 0.64 1,24 0.65 .42 51,1122 1.78 <0.001 .0.84		HS. I		1,54	0.01	.93	51,2581	1.81	.003	-0.21	.83	
1,24 0.65 .42 51,1122 1.78 <0.0010.84		_ 3		1,28	0.35	.55	51,1357	1.30	80.	79.0	.52	
		E		1,24	0.65	. 42	51,1122	1.78	<0.001	0.84	04.	

Oxygen Consummation MEF  Per Kilogram F  G Book Weight:  MSF  I 1,54  Ox 44  I 1,24  Ox 40  S 11,128  I 1,66  S 1,128  I 1,66  S 1,1064  I 1,27  S 1,124  I 1,24  I 1,34  I 1,44  I 1,	PARAMETER	SEX	ANSFORMATION CODE*	10	DIFFERENCE BETWEEN MEANS (ANOVA)	rEEN ()	GINTE	GROUP VS TITE INTERACTION (ANOVA)	HE HOVA)	P. T. E.	RANK
He				dF	L.	ಶ	Ą	1	8	7	8
He	Oxygen Consummiton	72.1									
NEF   1,54   0.52   47   51,2447   1.37   0.4   0.67     F   1,28   0.44   .15   51,1281   1.06   .34   0.47     H   1,24   0.40   .99   51,1064   1.27   .99   0.69     F   1,24   0.15   .70   51,2418   0.83   .80   -0.66     F   1,28   1.63   .21   51,1232   1.15   .22   1.06     H   H   H   H   H   H   H   H   H	Per Kilogram	<u>.</u>									
HEF 1,54 0,52 .47 51,244; 1.37 .04 0.67  HEF 1,28 0.44 .15 51,1281 1.06 .34 0.49  HEF 1,24 0.40 .99 51,1064 1.27 .99 0.69  HEF 1,54 0.15 .70 51,2418 0.83 .80 -0.66  1,24 0.57 .46 51,1084 0.86 .74 -0.94  HEF 1,54 0.57 .46 51,1084 0.86 .74 -0.94  HEF 1,54 2.29 .14 51,2300 0.92 .62 1.03 .88  HEF 1,54 2.29 .14 51,2300 0.92 .48 0.38 .16  HEF 1,54 2.29 .14 51,2300 0.92 .48 0.38 .16  HEF 1,54 2.29 .14 51,2300 0.92 .48 0.38 .16  HEF 1,54 0.65 .43 51,1035 0.99 .48 0.38 .14  HEF 1,54 0.65 .43 51,1035 0.99 .48 0.38 .14  HEF 1,54 0.00 .94 51,1173 1.34 .06 1.44 51,1173 1.34 .06 1.44 51,1173 1.34 .18 1.44 51,24 0.00 .94 51,1173 1.34 .18 1.44 51,24 0.00 .94 51,1173 1.34 .18 1.44 51,43 .	Of Body Weight	. *									
Net	1116 in (100 in	1				١	•				
HAFF HAFF HAFF HAFF HAFF HAFF HAFF HAFF		ָ בְּי		, .	0.52	74.	51,2447	1.37	<b>3</b> .	0.67	.25
HSF		<b>L</b> ;		1,28	<b>7.</b> 0	. 15	51,1281	1.06	.34	0.47	63
F       HEF         F       1,54       0.15       .70       51,2418       0.83       .80       -0.66         F       1,28       1.63       .21       51,1232       1.15       .22       1.06         H       1,24       0.57       .46       51,1084       0.86       .74       -0.94         HF       1,54       2.29       .14       51,2300       0.92       .62       1.03         F       1,54       2.29       .14       51,1330       0.92       .62       1.03         F       1,54       2.29       .09       51,1163       1.15       .21       1.68         H       1,24       0.65       .43       51,1035       0.99       .48       0.38         H       1,24       1.74       .19       51,1035       0.99       .48       0.38         H       1,28       4.89       .04       51,1173       1.16       .21       1.44         H       1,24       0.00       .94       51,977       1.18       .18       0.49		£		1,24	0.40	ę. 8	51,1064	1.27	85.	0.69	, 5;
F 1,54 0.15 .70 51,2418 0.83 .80 -0.66 1,24 1 1,24 0.57 .46 51,1084 0.86 .74 -0.94 1,084 1,24 0.57 .46 51,1084 0.86 .74 -0.94 1,094 1,24 0.57 .46 51,1084 0.86 .74 -0.94 1,28 1,28 2.99 .09 51,1163 1.15 .21 1.68 1,24 0.65 .43 51,1035 0.99 .48 0.38 1,18 1,24 0.00 .94 51,173 1.34 .06 1.43 1,44 1,124 0.00 .94 51,173 1.34 .06 1.43 1,144 1,24 0.00 .94 51,173 1.34 .06 1.43 1,24 0.00 .94 51,173 1.34 .06 1.43 1,24 0.00 .94 51,177 1.18 .18 0.49 1.49	arbon Dioxide	H.S.F.									
HEF 1,54 0.15 .70 51,2418 0.83 .80 -0.66  1,28 1.63 .21 51,1232 1.15 .22 1.06  HEF 1,24 0.57 .46 51,1084 0.86 .74 -0.94  HEF 1,24 2.29 .14 51,2300 0.92 .62 1.03  HEF 1,28 2.99 .09 51,1163 1.15 .21 1.68  HEF 1,24 0.65 .43 51,1035 0.99 .48 0.38  HEF 1,54 1.74 .19 51,2272 1.16 .21 1.44  HEF 1,54 1.74 .19 51,1272 1.16 .21 1.44  HEF 1,54 0.00 .94 51,1173 1.34 .06 1.43	Production	u									
HEF 1,54 0.15 .70 51,2418 0.83 .80 -0.66 1,24 1,24 1,24 1,24 1,63 .21 51,123 1.15 .22 1.06 1,24 1,24 0.57 .46 51,1084 0.86 .74 -0.94 1,24 0.57 .46 51,1084 0.86 .74 -0.94 1,24 0.65 .43 51,1035 0.99 .48 0.38 1,163 1.15 1.16 1.16 1.16 1.16 1.16 1.16 1.16		. 3									
HSF		E 1		ī	•	į	•	,			
HSF		i i		±2,1	0.15	2.	51,2418	0.83	80	-0.66	.95
HEF		<b>.</b> , 2		07,1	1.63	.21	51,1232	1.15	.22	1.06	.23
HEF H HEF HSF HSF HSF HSF HSF HSF HSF HS		E		1,24	0.57	94.	51,1084	0.86	.74·	-0.94	.34
F H H F 1,54 2.29 .14 51,2300 0.92 .62 1.03	arbon Dioxide	MEF									
HSF 1,54 2.29 .14 51,2300 0.92 .62 1.03 1.28 2.99 .09 51,1163 1.15 .21 1.68 1.28 1.24 0.65 .43 51,1035 0.99 .48 0.38 HSF F 1,54 1.74 .19 51,2272 1.16 .21 1.44 1.28 4.89 .04 51,1173 1.34 .06 1.43 1.34 0.00 .94 51,997 1.18 1.8 0.49	Production	u									
HSF 1,54 2.29 .14 51,2300 0.92 .62 1.03 1.28 2.99 .09 51,1163 1.15 .21 1.68 1.28 1.24 0.65 .43 51,1035 0.99 .48 0.38 HSF F 1,54 1.74 .19 51,2272 1.16 .21 1.44 1.24 0.00 .94 51,1173 1.34 .06 1.43 1.34 0.00 .94 51,997 1.18 1.8 0.49	Per Kilogram	. х									
HEF 1,54 2.29 .14 51,230 0.92 .62 1.03 1,28 2.99 .09 51,1163 1.15 .21 1.68 1.68 1,24 0.65 .43 51,1035 0.99 .48 0.38   HEF HEF 1,54 1.74 .19 51,2272 1.16 .21 1.44 1,24 0.00 .94 51,173 1.34 .06 1.43 1.54 0.00 .94 51,997 1.18 .18 0.49	4 Ports 15 15 15 15 15 15 15 15 15 15 15 15 15	- 1		٠							
HEF 1,28 2.99 .09 51,1163 1.15 .21 1.68 1,24 0.65 .43 51,1035 0.99 .48 0.38 1.8	r body weight	131		1,54	2.29	14	51,2300	0.92	.62	1.03	20
H 1,24 0.65 .43 51,1035 0.99 .48 0.38  HE F 1,54 1.74 .19 51,2272 1.16 .21 1.44  H 1,24 0.00 .94 51,1173 1.34 .06 1.43		u,		1,28	2.99	60.	51, 1163	1, 15	7.	84.	9
HEF H HEF 1,54 1,74		ĸ		1,24	0.65	Ą	51,1035	0.99	87	. c	5 6
HEF F H HSF 1,54 1.74 .19 51,2272 1.16 .21 1.44 F 1,28 4.89 .04 51,1173 1.34 .06 1.43 H 1,24 0.00 .94 51,997 1.18 .18 0.49									•	2.5	11.
F HSF 1,54 1.74 .19 51,2272 1.16 .21 1.44 1.28 4.89 .04 51,1173 1.34 .06 1.43 1.44 1.24 0.00 .94 51,997 1.18 .18 0.49	espiratory	MEF									
1,54 1.74 .19 51,2272 1.16 .21 1.44 1,28 4.89 .04 51,1173 1.34 .06 1.43 1,24 0.00 .94 51,997 1.18 .18	Quotient	u.									
1,54 1.74 .19 51,2272 1.16 .21 1.44 1,28 4.89 .04 51,1173 1.34 .06 1.43 1.34 1.64 1.43 1,24 0.00 .94 51,997 1.18 .18 0.49		x									
1,24 0.00 .94 51,997 1.18 .18 0.49		HSF		1 54	1 74	Ģ	r. 22.22	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	;		•
1,24 0.00 .94 51,997 1.18 .18 0.49		L		, ,	+ c	. ·	2/77,15	٠:٠	.21	1.44	.16
1,24 0.00 .94 51,997 1.18 0.49		. 3		07,1	4. 9.	<b>3</b> .	51,11/3	1.34	90.	1.43	91.
		E		1,24	0.00	<u>.</u>	51,997	.18	£,	P4 0	63

## DISCUSSION

The most significant finding was the difference in rate of weight gain between exposed and control males. The exposed males gained weight at a faster rate than did the control males. This difference in weight was not accompanied by a difference in bone length measurements. The linear body measurement showing the most agreement with growth rate was chest circumference, which may indicate an increase in mass of the pectoral and upper back muscles. Subjective evaluations did not indicate a difference in subcutaneous fat. The tentative assumption is that the increased weight was primarily muscle mass.

Blood urea nitrogen (BUN) was lower (P=0.05) in the exposed males; this is consistent with the growth rate finding in that the higher anabolic rate should result in less nitrogen as catabolites. Serum glucose was also lower (P=0.01) in the exposed  $m_{\rm c}$ , however, values for both experimental and control groups were well within the normal range.

Gamma-glutamyl transpeptidase (GGTP) was lower in the exposed males (P=0.06), and although consistently lower in exposed females, the difference was not significant (P=0.37). In the males the difference tended to increase slightly with time while in the females the difference tended to decrease with time. Although the biochemistry of this enzyme has been only partially elucidated, the empirical data cited by Rosalki in a 1975 review (11) provides evidence that the GGTP and growth rates observed in the present study are consistent.

Three serum enzymes (glutamic oxaloacetic transaminase, glutamic pyruvic transaminase, and creatine phosphokinase) were significantly different (P=0.05) in the males for the day plots in the first week. In all three cases values for the exposed males were lower than the controls. The significant differences did not show up in the weekly plots although glutamic pyruvic transaminase continued to be less in the exposed males (P=0.14). Since the animals were restrained during the first week the hypothesis for a synergistic effect between restraint and exposure was tested by using the difference during the other restraint periods (weeks 7, 13, 19, 25, and 31) and comparing it with the difference immediately before the restraint periods (weeks 6, 12, 18, 24, and 30); a paired testatistic did not confirm the hypothesis for a synergistic effect. No explanation is yet available for the observed differences in these parameters.

Oxygen consumption was significantly different in the Group vs Time Interaction, but it was caused by an equipment and procedural artifact. Each of the twelve systems for measuring oxygen consumption served five unimals during the week. On Saturday the animals were transposed but the measuring equipment was not. This was done interactionally so that subtle equipment differences would be averaged out and not show an artifactual difference between means; however, this method enhanced the sensitivity of the ANOVA interaction term to slight equipment differences. To counter this artifact, these data were averaged over two successive data points which would include both measuring systems used by a given animal. Under these conditions the interaction was not significant (P=0.41).

Serum chloride in the males showed a significance (P=0.02) in the interaction term of the ANOVA. Regression analysis revealed a higher order interaction. There is no apparent agreement between this and the other observations, and the higher order interaction suggests an artifact (as in the case of oxygen consumption which was also higher order), but unlike cxygen no artifact has yet been found.

Serum triglycerides were lower in the exposed females (P=0.06 ANOVA, P=0.05 Rank). Respiratory quotient was also lower in the exposed females (P=0.04). These differences are qualitatively consistent, the lower respiratory quotient reflecting a higher percentage of lipids oxidized. The explanation and meaning of these differences are at present unknown.

The differences in weight are obviously real and there is no chance for an artifact in the measurements. The protocol has been examined in great detail and not even a remotely possible reason has been advanced to account for the experimental males being treated differently. The only reasonable explanation, other than a field effect, lies in the selection process. The animals were matched by weight, which is not necessarily the same as matching by growth rate. It is obviously possible that two animals could have identical weights at a given time but be growing at a different rate. The probability of this kind of mismatch was reduced by matching also for age, and, as indicated in the Results section, the criteria for age estimates were consistently applied even though the absolute values have recognized inaccuracies. The question hinges on the probability that in spite of these precautions, the random selection process produced highly mismatched groups of males only. The authors are unable to quantify such a probability but are inclined to believe that it is small.

Another factor to be considered is that growth rate occupies a somewhat unique position among the many parameters that were measured. Most blood chemistry parameters are under homeostatic control and when they deviate beyond certain limits, corrective processes are automatically set in motion that tend to reduce the deviation. While it is well known that many factors affect growth rate, the existence of feedback mechanisms that would make a high or low growth rate self-limiting is not known. The logical extension of this argument is that in response to environmental conditions, the growth rate may be a much more labil a parameter than those parameters under rigid homeostatic control.

The degree to which these homeostatic mechanisms are strained should also be considered in evaluating the overall physiological significance. For example, initial application of a reduced oxygen environment may be considered hazardous because the homeostatic reserve is diminished but after a period of adaptation the exygen carrying capacity is increased, the homeostatic reserve is restored, and the hazard is reduced. In this experiment a number of parameters have been changed. In some cases it is reasonably sure that homeostatic mechanisms have not been strained, but in other cases it is not clear. There is no reason to believe that reduced blood urea nitrogen is hazardous. Reduced serum glucose could be of concern at low levels, but the values for exposed males were well within normal range, and clinical experience does not justify labeling this condition as hazardous. Certain

pathological conditions have been associated with increased levels of gamma-glutamyl transpeptidase but not with reduced levels. For the exposed males, therefore, increased weight appears to be the most significant finding.

Based on statistics alone, the case for a cause and effect relationship between the ELF field parameters used in this experiment and increased growth rate in the males is strong. This conclusion can be either tempered or enhanced by mechanistic considerations. Anatomical and endocrine involvement are logical suspects for a sex specific effect. One plausible hypothesis is that the testes were in contact with the cage bars generating the electric field and were thus directly stimulated to increase the secretion rate of testosterone. Postural observations confirm that the animals spent considerable time sitting on the bars in such a way that the scrotum was in direct contact with the bars as shown in Figure 3. Under these conditions it is probable that the current density in the testes was higher than it would be for a walking or standing posture.

A second hypothesis suggests a more generalized neuroendocrine effect in which the hypothalamic-pituitary-gonad axis is stimulated by some mechanism that is not yet known. The sexual specificity could arise from the more potent effect of male gonadal hormones on growth. The sexual specificity could also be the result of difference in maturity relative to onset of puberty at the beginning of exposure. The weight of female rhesus at puberty is 3.5 to 4 kg. The mean weight of the females at the beginning of exposure was 4.9 kg. The mean weight of male rhesus at puberty is 6 to 8 kg. The mean weight of the males at the beginning of exposure was 6.0 kg. The females were therefore closer to their maximum somatic development at the beginning of exposure than were the males and may have been less susceptible to a stimulus that affects growth rate.

At the time of this report, the protocol is being developed to test the first two hypotheses experimentally. In general, eight distribution will be studied in terms of muscle mass, fat, and body water. The ratio of testosterone to gonadotropin will also be determined. For the hypothesis of direct stimulation to the testes, the level of serum testosterone and the ratio of testosterone to gonadotropin should be higher in the exposed males than in the controls. In the case of a generalized neuroendocrine effect, both the gonadotropin and testosterone should be higher in the exposed males.

The authors believe that primates are the best animal model for extrapolating environmental effects to humans; however, it is obvious that a study of growth and development in the primate is a difficult task in terms of logistics, time, and expense. An ideal experiment on growth and development would also require matched pairs, but they should have been born in captivity so that exact age and genetic history are known and can be used for matching.

The authors are not prepared to label the observed effects as either harmful or helpful. To be considered harmful it is only necessary that one or more changes produce an undesirable outcome. At present that does not appear to be the case; both groups of animals appear perfectly healthy in both the clinical and layman's sense of the word. It is tempting to apply the "bigger is better" logic and say that the exposure was helpful; however, the authors believe that such a conclusion, while providing interesting

speculation, is based on value judgments outside the realm of science and should not be a substitute for scientific research that provides a clearer definition of the effects and a logical basis for an overall evaluation.

## REFERENCES

- Beischer, D.E., Grissett, J.D., and Mitchel, R.E., Exposure of man to magnetic fields alternating at extremely low frequency. NAMRL 1180. Pensacola, Florida: Naval Aerospace Medical Research Laboratory, July 1973.
- Byrkit, Donald R., <u>Elements of Statistics</u>. Second Ed. New York:
   D. Van Nostrand Company, 1975. Pp 331-333
- de Lorge, J., Operant behavior of rhesus monkeys in the presence of extremely low frequency-low intensity magnetic and electric fields: Experiment 1. NAMRL 1155. Pensacola, Florida: Naval Aerospace Medical Research Laboratory, March 1972.
- 4. de Lorge, J., Operant behavior of rhesus monkeys in the presence of extremely low frequency-low intensity magnetic and electric fields: Experiment 2. NAMRL 1179. Pensacola, Florida: Naval Aerospace Medical Research Laboratory, March 1973.
- 5. de Lorge, J., Operant behavior of rnesus monkeys in the presence of extremely low frequency-low intensity magnetic and electric fields: Experiment 3. NAMRL 1196. Pensacola, Florida: Naval Aerospace Medical Research Laboratory, November 1973.
- de Lorge, J.O., A psychobiological study of rhesus monkeys exposed to extremely low frequency-low intensity magnetic fields. NAMRL 1203. Pensacola, Florida: Naval Aerospace Medical Research Laboratory, May 1974.
- 7. Grissett, J.D. and de Lorge, J.O., Central nervous system effects as measured by reaction time in squirrel monkeys exposed for short periods to extremely low-frequency magnetic fields. NAMRL 1137. Pensacola, Florida: Naval Aerospace Medical Research Laboratory, August 1971.
- 8. Grissett, J.D., Exposure of squirrel monkeys for long periods to extremely low frequency magnetic fields: Central nervous system effects as measured by reaction time. NAMRL 1146. Naval Aerom space Merical Research Laboratory, October 1971.
- 9. Liu, C.T. ar in the land A., Determination of body surface area in the rho and the land of Applied Physiology, 40:101-104, 1976.
- 10. Hicks, Charles ..., For Amental Concepts in the Design of Experiments, Second Ed. New York: Holt, Rhinehart, & Winston, 1973. Pp. 123-128
- 11. Rosalki, S.B., Gamma-glutamyl transpeptidase. In: Bodansky, O., and Latner, A.L. (Ed.) Advances in Clinical Chemistry, Vol. 17.
  New York, San Francisco, London: Academic Press, 1975. Pp 53-107.

12. Winer, B.J., <u>Statistical Principles in Experimental Design</u>. New York: McGraw-Hill Book Company, 1962. Pp 105-162 and 241-244.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) READ INSTRUCTIONS BEFORE COMPLETING FORM REPORT DOCUMENTATION PAGE rept. Oct 15- Dec NAMRL-1240 KEPORT & PERIOD COVERED Exposure of Primates for One Year to Electric Interim, October 1975 and Magnetic Fields Associated with ELF December 1976 Communications Systems. 6. PERFORMING ORG, REPORT NUMBER Matthew J. /Kessler, Richard J. /Brown George D. /Prettyman 8. CONTRACT OR GRANT NUMBER(4) and Toby Awariner PERFORMING ORGANIZATION NAME AND ADDRESS PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Naval Aerospace Medical Research Laboratory Pensacola, FL 32508 XSB09-ED6.6-B1 11. CONTROLLING OFFICE NAME AND ADURESS 12. REPORT DATE Naval Medical Research and Development Command November 1277 National Naval Medical Center NUMBER OF PAGES Bethesda, MD 20014 315 14. MONITORING AGENCY NAME & ADDRESS(II different from Controlling Office) 18. SECURITY CLASSING this report) Unclassifi DECLASSIFICATION BOWN SHADING 16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited. 17. DISTRIBUTION STATEMENT (of the abetract entered in Block 20, if different from Report) IR. SUPPLEMENTARY NOTES 19. KEY WORDS (Continue on reverse side if necessary and identity by block number) Nonionizing Radiation Physiology of primates Electromagnetic fields Rhesus Extremely low frequency fields Macaca mulatta Magnetic fields Blood chemistry Electric fleids Biochemistry 20. And TACT (Continue on reverse side if necessary and identity by block number)
The U.S. Navy has proposed a submarine communications system that operate: at extremely low frequencies. In order to more thoroughly evaluate the blological and ecological effects which could not be adequately predicted on the basis of available data in the literature, the Navy initiated an in-depth laboratory analysis. Experimental animals were exposed for long periods to electric and magnetic fields similar to or greater than those that would be experienced by man living near the antenna. Thirty experimental rhesus monkeys were matched with thirty controls and exposed for one year. 7 (OVER) DD 1 JAN 73 1473

406061

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered)

EDITION OF I NOV 65 IS OBSOLETE

\$/N 0102-014-6601 |

Ch

par.

DRITY CLASSIFICATION OF THIS PAGE(When Date Entered) Although not considered abnormal, the most significant finding was the difference in rate of weight gain between exposed and control males. The exposed males gained weight at a slightly faster rate than the control males and at the end of one year were approximately 11% heavier than the controls. The difference in weight was not accompanied by an increase in bone length measurements. The linear body measurement showing the most agreement with the growth rate difference was chest circumference. In the exposed females serum triglycerides and respiratory quotient were slightly lower than in the female controls. There is no indication that these findings have any adverse clinical significance and both groups of animals appear quite healthy.